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CONTENTS

PEOPLES REPUBLIC OF CHINA

APPLIED SCIENCES

Dynamics of Attitude Control of Spin-Stabilized Satellite (Xing Guangqian; ZIDONGHUA XUEBAO, Jan 81)........ 1

ABSTRACTS

BUILDING CONSTRUCTION

JIANZHU [BUILDING CONSTRUCTION], No 7, 30 Jul 81........ 18

CONSTRUCTION MACHINERY

GONGCHENG JIXIE [CONSTRUCTION MACHINERY], No 6, 1981........ 20

ELECTRONICS

DIANZI JISHU [ELECTRONIC TECHNOLOGY], No 7, 20 Jul 81........ 22

DIANSHIJIE [ELECTRICAL WORLD], No 7, 1981........ 23

ENGINEERING

TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY], No 2, 1981........ 24

GEOCHEMISTRY

DIQIU HUAXUE [GEOCHIMICA], No 2, 1981........ 30

HYDROGEOLOGY

SHUIWEN DIZHI GONGCHENG DIZHI [HYDROGEOLOGY AND ENGINEERING GEOLOGY], No 3, 1981.. 39

MACHINERY

JIXIE ZHIZAO [MACHINERY], No 7, 1981.................................. 41

METALS

JINSHU RECHULI [HEAT TREATMENT OF METALS], No 6, 1981................. 42

JINSHU RECHULI [HEAT TREATMENT OF METALS], No 7, 1981.................. 44

MICROBIOLOGY

WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA], No 2, 1981............. 45

OCEANOLOGY

HAIYANG XUEBAO [ACTA OCEANOLOGICA SINICA], No 2, Jun 81................ 47

TUNNEL ENGINEERING

DIXIA GONGCHENG [UNDERGROUND ENGINEERING], No 6, 1981................... 49

UNDERGROUND ENGINEERING

DIXIE GONGCHENG [UNDERGROUND ENGINEERING], No 7, 1981................... 51

VACUUM TECHNOLOGY

ZHENKONG [VACUUM], No 3, 1981.. 52

APPLIED SCIENCES

DYNAMICS OF ATTITUDE CONTROL OF SPIN-STABILIZED SATELLITE

Beijing ZIDONGHUA XUEBAO [ACTA AUTOMATICA SINICA] in Chinese Vol 7 No 1, Jan 81 pp 42-54

[Article by Xing Guangqian [6717 0342 6197] of the Beijing Control Engineering Institute: "Dynamics of Attitude Control of a Spin-Stabilized Satellite". This article was read at the National Space Control Technology Conference in April, 1979. The revised article was received on 30 July 1980.]

[Text] Abstract

This article discusses the dynamics of mechanical maneuvers to position a spin-stabilized satellite at any desired attitude. The article derives a set of analytic expressions of attitude movements of the satellite acted upon by a set of pulsed control moments of force. These formulas describe the patterns of change between the angular momentum, nutation angle, attitude phase angle and the controlling momentum and number of times of control. They can be directly applied in the design of satellite attitude control systems and attitude determination.

It must be pointed out that controlling the spin axis of the satellite to a position perpendicular to the plane of the orbit or controlling the spin axis towards the sun are two special cases of the results of this article.

I. Proposing the Problem

In the design of the attitude control system of the spin-stabilized satellite, because the auxiliary rocket on the satellite used for attitude control is fixed on the body of the satellite, therefore, as the satellite spins, the direction of the controlling moment of force produced by the auxiliary rocket will also rotate about the spin axis in space. According to the theorem of angular momentum of a rigid body, we know: "When a rotating body is acted upon by an external moment of force, the vector of its angular momentum will slant towards the direction of the moment of force." Therefore, to control the spin axis toward a desired direction, the rocket on the satellite can only be fired periodically and discontinuously, not continuously. At the same time, the following problems must be solved:

(1) How to select the phase of the discontinuous rocket control? What are the patterns?

(2) Within a definite cycle of discontinuous moments of force, what is the pattern of the attitude movements?

(3) The relationship between the moment of force, the number of times and the attitude movement parameters.

Discussion of the pattern of attitude movements under discontinuous moments of force is a mathematical discussion of the solution of a set of equations of Eulerian mechanics and kinematics describing the attitude movements. This problem can approximate the analytic solution of the problem within an allowable range of error. It is very important in both the design of the attitude control system and the attitude measuring system. It is also the problem that we want to study.

Let us assume that there is an inertial reference system $\{\hat{i},\hat{j},\hat{k},o\}$ on a unit spherical surface (See Figure 1). If we control the attitude A of the spin axis to C, we can generally do it in two ways: One is to travel along the great arc $\overset{\frown}{AmC}$, from A to C. The other route is to travel the so-called "isogonic" locus $\overset{\frown}{AnC}$. The name isogonic came about because the angle formed by the tangential direction of any point on the isogonic and the point's meridian is always the same. Obviously, the angle formed by the tangential direction of any point on the great arc and the point's meridian is not the same. Therefore, from the engineering point of view, the "isogonic" method of control is simpler than the great arc method, even though the distance traveled by the great arc method is shorter than the distance traveled by the "isogonic" method (therefore less fuel is consumed), but in engineering, the "isogonic" method of control is still preferred.

It can be seen from Figure 1 that when the desired attitude C is on the equatorial plane (for example, at the position B) or on the meridian plane (for example, at the position D), the locus of the great arc and the locus of the "isogonic" coincide, the isogonic angle of the desired attitude on the equatorial plane is 0 or π. In 1970, a German, Schmieder, published the research results of two types of special desired attitudes (1), the results were consistent with the results in a report written by this author (abbreviated as "the report" in the following)*. This article will mainly discuss the dynamics of controlling any desired attitude and will give an analytic solution of attitude dynamics for the controlling process using the "isogonic" method of control of any desired attitude. This analytic solution has not yet been seen in foreign publications. This problem has only been solved by a graphic geometric method (2) in studies of nutation control. The method we discuss is a completely analytic method. Of course, the results can also be represented by the graphic method.

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*The report presented at the National Space Control Technology Conference in April, 1979.

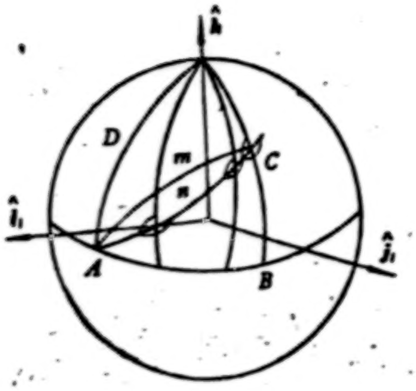

Figure 1. Loci of the attitude control by the great arc and the "isogonic" methods.

II. Analysis of the Dynamics of Attitude Control for Any Desired Attitude

In actual attitude control, because of the limitations of the attitude measuring components, we must consider the problem of "isogonic" control of any desired attitude. But the difficulty is that if the initial attitude and the desired attitude in the "isogonic" control method are not on the same plane, then an inertial attitude reference system cannot be found for describing the attitude in this inertial reference system and for finding an approximate analytic solution. To overcome this difficulty, we select a set of specific attitude parameters as the quantities of the attitude state and describe the attitude movement in this specific reference system, and finally we find the analytic solution of the problem.

Reference System

We establish the following reference system:

$R^I:\{\hat{i}_I,\hat{j}_I,\hat{k}_I,o\}$	The inertial reference system of the center of mass of the satellite, the center of the system is at the center of mass of the satellite and the system is parallel to the geocentric inertial system;
$R^s:\{\hat{i}_s,\hat{j}_s,\hat{k}_s,o\}$	Solar reference system of the center of mass of the satellite;
$R^h:\{\hat{i}_h,\hat{j}_h,\hat{k}_h,o\}$	Angular momentum reference system of the center of mass of the satellite;
$R^b:\{\hat{i}_b,\hat{j}_b,\hat{k}_b,o\}$	The coordinates system of the center of mass of the satellite itself.

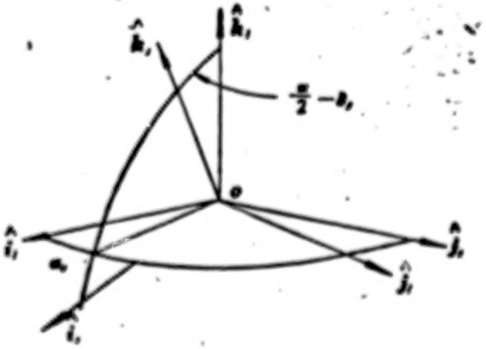

Figure 2. The inertial system of the center of mass of the satellite and the solar reference system

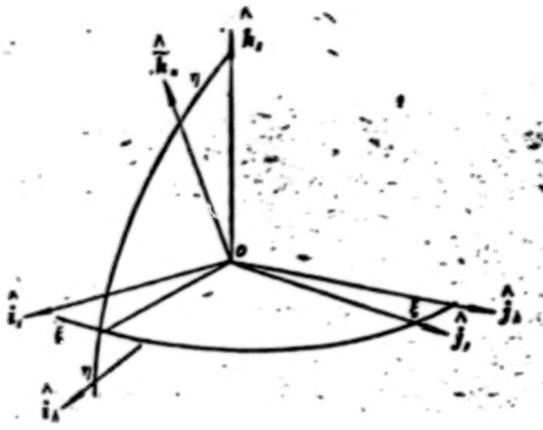

Figure 3. The solar reference system and the angular momentum reference system of the satellite

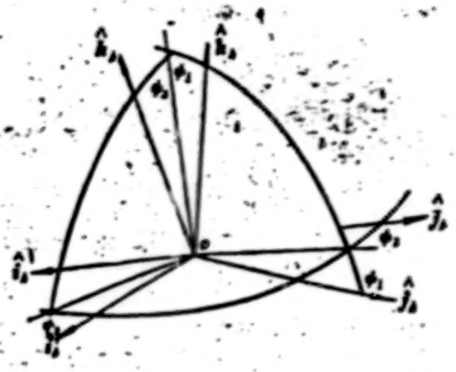

Figure 4. The angular momentum reference system of the satellite and the satellite's own reference system

The transformation of coordinates among the above coordinates systems are:

$$\begin{pmatrix} \hat{i}_s \\ \hat{j}_s \\ \hat{k}_s \end{pmatrix} = A_{sI} \begin{pmatrix} \hat{i}_I \\ \hat{j}_I \\ \hat{k}_I \end{pmatrix}, \tag{1}$$

$$A_{sI} = R_y\left(\frac{\pi}{2} - \delta_s\right) R_z(\alpha_s) \tag{2}$$

$$\begin{pmatrix} \hat{i}_h \\ \hat{i}_h \\ \hat{k}_h \end{pmatrix} = A_{hs} \begin{pmatrix} \hat{i}_s \\ \hat{j}_s \\ \hat{k}_s \end{pmatrix}, \tag{3}$$

$$A_{hs} = R_y(\eta) R_z(\xi), \tag{4}$$

$$\begin{pmatrix} \hat{i}_b \\ \hat{j}_b \\ \hat{k}_b \end{pmatrix} = A_{bh} \begin{pmatrix} \hat{i}_h \\ \hat{j}_h \\ \hat{k}_h \end{pmatrix}, \tag{5}$$

$$A_{bh} = R_z(\phi_3) R_y(\phi_2) R_z(\phi_1). \tag{6}$$

$R_x(\cdot)$, $R_y(\cdot)$, $R_z(\cdot)$ are respectively the transformation matrices of the single rotation coordinates about the x, y, z axis, their forms are:

$$R_x(\cdot) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos(\cdot) & \sin(\cdot) \\ 0 & -\sin(\cdot) & \cos(\cdot) \end{pmatrix}, \quad R_y(\cdot) = \begin{pmatrix} \cos(\cdot) & 0 & -\sin(\cdot) \\ 0 & 1 & 0 \\ \sin(\cdot) & 0 & \cos(\cdot) \end{pmatrix},$$

$$R_z(\cdot) = \begin{pmatrix} \cos(\cdot) & \sin(\cdot) & 0 \\ -\sin(\cdot) & \cos(\cdot) & 0 \\ 0 & 0 & 1 \end{pmatrix}. \tag{7}$$

2. Dynamic Equations

It is not difficult to derive the angular velocity ω_{bs} of R^h relative to R^s from the above transformation relationships of the coordinates

$$\omega_{bs} = \dot{\xi}\hat{k}_s + \dot{\phi}_1\hat{i}_h + (\dot{\eta} + \dot{\phi}_2\cos\phi_1)\hat{j}_h + \dot{\phi}_2\sin\phi_1\hat{k}_h + \dot{\phi}_3\hat{k}_b. \tag{8}$$

Obviously, if the projection of ω_{bs} in R^b is written as ω_{bs}^b, then

$$\omega_{bs}^b = A_{bh}A_{hs}\begin{pmatrix}0\\0\\\dot{\xi}\end{pmatrix} + A_{bh}\begin{pmatrix}\dot{\phi}_1\\\dot{\eta} + \dot{\phi}_2\cos\phi_1\\\dot{\phi}_2\sin\phi_1\end{pmatrix} + \begin{pmatrix}0\\0\\\dot{\phi}_3\end{pmatrix} \tag{9}$$

Let the inertial tensor I of the main axis of the satellite be

$$I = \begin{pmatrix}I_x & 0 & 0\\0 & I_y & 0\\0 & 0 & I_z\end{pmatrix}, \tag{10}$$

then the angular momentum H in R^b is

$$H = I\omega_{bs}^b \tag{11}$$

On the other hand, in R^b, the angular momentum is

$$H^b = \begin{pmatrix}0\\0\\h\end{pmatrix}, \tag{12}$$

thus in R^b, the angular momentum H is

$$H = A_{bh}\begin{pmatrix}0\\0\\h\end{pmatrix}, \tag{13}$$

Simultaneously solving equations (11) and (13) for ϕ_1, ϕ_2, ϕ_3,

$$\begin{aligned}\dot{\phi}_1 = \frac{1}{\cos\phi_2}\Big\{&\dot{\xi}[\sin\eta\cos\phi_2 + \cos\eta\sin\phi_2\cos\phi_1] + \dot{\eta}(-\sin\phi_2\sin\phi_1)\\&- h\sin\phi_2\cos\phi_1\left[\frac{\cos^2\phi_3}{I_x} + \frac{\sin^2\phi_3}{I_y}\right] + h\sin\phi_1\sin\phi_3\cos\phi_3\left(\frac{1}{I_x} - \frac{1}{I_y}\right)\Big\},\end{aligned} \tag{14}$$

$$\begin{aligned}\dot{\phi}_2 = -\dot{\xi}\cos\eta\sin\phi_1 - \dot{\eta}\cos\phi_1 - \sin\phi_2\cos\phi_1\cos\phi_3\sin\phi_3 h\left[\frac{1}{I_x} - \frac{1}{I_y}\right]\\+ \sin\phi_1 h\left[\frac{\sin^2\phi_3}{I_x} + \frac{\cos^2\phi_3}{I_y}\right],\end{aligned} \tag{15}$$

$$\dot{\phi}_3 = \frac{h}{I_z}\cos\phi_2\cos\phi_1 - \dot{\xi}\cos\eta\cos\phi_1\frac{1}{\cos\phi_2} + \dot{\eta}\frac{\sin\phi_1}{\sin\phi_2} + h\,\mathrm{tg}\,\phi_2 \cdot$$

$$\cdot \sin\phi_2\cos\phi_1\left(\frac{\cos^2\phi_3}{I_x} + \frac{\sin^2\phi_3}{I_y}\right) - h\sin\phi_1\sin\phi_3\cos\phi_3\,\mathrm{tg}\,\phi_2\left(\frac{1}{I_x} - \frac{1}{I_y}\right). \tag{16}$$

Everyone knows that the dynamic equations of the angular momentum in R^h are:

$$\frac{dH^h}{dt} = \frac{\partial H^h}{\partial t} + \omega_{hi} \times H^h = M^h, \tag{17}$$

where

$$H^h = \begin{pmatrix} 0 \\ 0 \\ h \end{pmatrix}, \tag{18}$$

$$\omega_{hi} = \begin{pmatrix} -\sin\eta\dot{\xi} \\ \dot{\eta} \\ \cos\eta\dot{\xi} \end{pmatrix}. \tag{19}$$

M^h is the projection of the controlling moment of force in R^h.

We can write equation (17) in component form and substitute it into equations (1^A -- 16) and simplify to obtain the complete set of dynamic equations describing the attitude movement:

$$\dot{\xi} = \frac{M_y^h}{h\sin\eta}, \tag{20}$$

$$\dot{\eta} = \frac{M_x^h}{h}, \tag{21}$$

$$\dot{h} = M_z^h, \tag{22}$$

$$\dot{\phi}_1 = -h\,\mathrm{tg}\,\phi_2\cos\phi_1\left[\frac{\cos^2\phi_3}{I_x} + \frac{\sin^2\phi_3}{I_y}\right] + \frac{h\sin\phi_1\sin\phi_3\cos\phi_3}{\cos\phi_2}\left[\frac{1}{I_x} - \frac{1}{I_y}\right]$$

$$+ [\sin\eta + \cos\eta \cdot \mathrm{tg}\,\phi_2\cos\phi_1]\frac{M_y^h}{h\sin\eta} - \mathrm{tg}\,\phi_2\sin\phi_1\frac{M_x^h}{h}, \tag{23}$$

$$\dot{\phi}_2 = \sin\phi_1\left[\frac{\sin^2\phi_3}{I_x} + \frac{\cos^2\phi_3}{I_y}\right]h - \cos\phi_1\sin\phi_3\sin\phi_3\cos\phi_3 h\left[\frac{1}{I_y} - \frac{1}{I_y}\right]$$

$$- \cos\eta\sin\phi_1\frac{M_y^h}{h\sin\eta} - \cos\phi_1\frac{M_x^h}{h}, \tag{24}$$

$$\dot{\phi}_3 = \frac{h}{I_z}\cos\phi_2\cos\phi_1 + h\,\mathrm{tg}\,\phi_2\sin\phi_1\cos\phi_1\left[\frac{\cos^2\phi_3}{I_x} + \frac{\sin^2\phi_3}{I_y}\right]$$

$$- h\sin\phi_1\sin\phi_3\cos\phi_3\,\mathrm{tg}\,\phi_2\left(\frac{1}{I_x} - \frac{1}{I_y}\right)$$

$$- \cos\eta\cos\phi_1\frac{M_y^h}{h\sin\eta\cos\phi_2} + \frac{\sin\phi_1 M_x^h}{\cos\phi_2 h}. \tag{25}$$

If the satellite is a symmetrically rotating body, i.e., when $I_x = I_y$ then equations (20 - 25) can be simplified as:

$$\dot{\xi} = \frac{M_y^*}{h \sin \eta}, \tag{26}$$

$$\dot{\eta} = \frac{M_x^*}{h}, \tag{27}$$

$$\dot{h} = M_z^*, \tag{28}$$

$$\dot{\phi}_1 = -\frac{h}{I_{II}} \operatorname{tg} \phi_2 \cos \phi_1 + [1 + \operatorname{ctg} \eta \operatorname{tg} \phi_2 \cos \phi_1] \frac{M_y^*}{h} - \operatorname{tg} \phi_2 \sin \phi_1 \frac{M_x^*}{h}, \tag{29}$$

$$\dot{\phi}_2 = \frac{h \sin \phi_1}{I_{II}} - \operatorname{ctg} \eta \sin \phi_1 \frac{M_y^*}{h} - \cos \phi_1 \frac{M_x^*}{h}, \tag{30}$$

$$\dot{\phi}_3 = \frac{h}{I_z} \cos \phi_2 \cos \phi_1 + \frac{h}{I_{II}} \operatorname{tg} \phi_2 \sin \phi_2 \cos \phi_1 - \operatorname{ctg} \eta \frac{\cos \phi_1}{\cos \phi_2} \frac{M_y^*}{h} + \frac{\sin \phi_1 M_x^*}{\cos \phi_2 h}, \tag{31}$$

where

$$I_{II} = I_x = I_y . \tag{32}$$

3. Attitude Movements Under the Isogonic Pulse Moment of Force

First we examine the moments of force acting upon the satellite. As illustrated in Figure 5, in general, the attitude control rocket tube is fitted parallel to the spin axis and is at a distance from the spin axis; this distance is the arm of force.

As Figure 5 shows, because the rocket for attitude control on the satellite is fixed to the body of the spin satellite, therefore when the satellite makes one revolution, the attitude control moment of force of the rocket M also makes one revolution in space. Thus, to control the attitude control moment of force to a direction perpendicular to the plane of the spin axis, a known phase reference base must be given.

If we select the pulse at the line between the meridian plane of the satellite and the sun as the standard of the reference phase, then $\hat{k}_I$ in Figure 1 should represent the vector $\hat{s}$ of the direction of the sun. We call the angle made by the spin axis--the vector plane of the direction of the sun and the spin axis--the plane of the controlling moment of force the "phase angle of the controlling moment of force", and use β to represent it. In this way, the so-called "isogonic" control becomes a control of the phase angle β of the controlling moment of force so that it equals a certain constant. This constant is determined by the initial attitude and the desired attitude. We know that during a certain period of rocket maneuvers the combined moment of force of the rocket must be pointed towards the desired direction. Theoretically, the shorter the duration of rocket maneuvers the better, but for the machinery executing the maneuvers, the shorter the duration of maneuvers the poorer the repeatability, and the more difficult it is to develop.

But, a long duration of maneuvers wastes fuel. According to analysis, it is best to choose a maneuvering angle (i.e., the product of the duration of the maneuver and the velocity of rotation of the satellite) of 45° to 60°. For convenience of analysis and in order not to lose generality, we assume that the controlling moment of force is in ideal pulses, and it is described mathematically by the δ function.

As Figure 5 shows, the phase angle of the line between the rocket tube and the meridian of the solar sensor is β_j, therefore the moment of force in R^b is:

$$\boldsymbol{M} = \begin{pmatrix} \cos\left(\beta_j - \frac{\pi}{2}\right) \\ \sin\left(\beta_j - \frac{\pi}{2}\right) \\ 0 \end{pmatrix} |\boldsymbol{M}| = \begin{pmatrix} \sin\beta_j \\ -\cos\beta_j \\ 0 \end{pmatrix} |\boldsymbol{M}|. \qquad (33)$$

The forms of the components in R^h are:

$$\boldsymbol{M}^h = A_{hb}^{-1}\boldsymbol{M} = R_z(-\phi_3)R_x(-\phi_2)R_z(-\phi_1)\begin{pmatrix} \sin\beta_j \\ -\cos\beta_j \\ 0 \end{pmatrix} |\boldsymbol{M}|, \qquad (34)$$

Because the controlling moment of force is very small, the attitude variation thus caused can be regarded as a first order infinitesimal quantity,

$$\phi_1 = 0 \qquad \phi_2 = 0 \qquad (35)$$

At the same time, we assume the meridian line of the solar sensor sees the sun at time t_s, the pulsed action of the controlling moment of force occurs τ_s after t_s, if the moment of force is regarded as an ideal pulse, then equation (34) can be simplified as:

$$\boldsymbol{M}^h = \begin{pmatrix} \sin(\phi_3 + \beta_j) \\ -\cos(\phi_3 + \beta_j) \\ 0 \end{pmatrix} |\boldsymbol{M}| \delta(t - t_s - \tau_s). \qquad (36)$$

In the following, we will discuss the time of occurrence of the pulse of the solar line. In R^h, the directional vector $\hat{s}$ of the sun and the spin axial vector $\hat{p}$ are:

$$\hat{s} = A_{hi}\begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} = \begin{pmatrix} -\sin\eta \\ 0 \\ \cos\eta \end{pmatrix}, \qquad (37)$$

$$\hat{\beta}^s = R_z(-\phi_3)\begin{pmatrix}0\\0\\1\end{pmatrix} = \begin{pmatrix}0\\0\\1\end{pmatrix}, \tag{38}$$

$$\hat{j}_b^s = R_z(-\phi_3)\begin{pmatrix}0\\1\\0\end{pmatrix} = \begin{pmatrix}-\sin\phi_3\\ \cos\phi_3\\ 0\end{pmatrix}, \tag{39}$$

$$\hat{i}_b^s = R_z(-\phi_3)\begin{pmatrix}1\\0\\0\end{pmatrix} = \begin{pmatrix}\cos\phi_3\\ \sin\phi_3\\ 0\end{pmatrix}. \tag{40}$$

Obviously, the solar pulse should satisfy the ~~following condit~~ions:

$$\begin{cases}\hat{s}^s \cdot \hat{j}_b^s = 0\\ \hat{s}^s \cdot \hat{i}_b^s \geq 0\end{cases} \tag{41}$$

These are expanded to become:

$$\begin{cases}\sin\phi_3 \sin\eta = 0\\ -\sin\eta\cos\phi_3 \geq 0\end{cases} \tag{42}$$

Substituting equation (36) into equation (28) and equation (31) and neglecting the higher order infinitesimal quantities, we obtain:

$$\dot{\phi}_3 = \frac{h}{I_z} = \Omega. \tag{43}$$

If $\phi_3 = 0$ when $t = 0$ (44)

then $\phi_3 = \Omega t$ (45)

Substituting equation (45) into equation (42), we obtain:

$$\phi_3 = \pi,\ 3\pi,\ 5\pi,\ \cdots(2n-1)\pi,\quad (n = 1, 2, 3\cdots).$$

Obviously, the above angle is the ϕ_3 value when the solar pulse occurs, its corresponding time is:

$$t_{s_1} = \frac{\pi}{\Omega},\quad t_{s_2} = \frac{3\pi}{\Omega},\quad t_{s_3} = \frac{5\pi}{\Omega},\ \cdots\ t_{s_n} = \frac{(2n-1)\pi}{\Omega}. \tag{46}$$

In the following, we will discuss the pattern of the isogonic control moments of force.

According to Figure 5, we know from the geometric relationship between the rocket tube and the line of the meridian plane of the solar sensor that if the rocket is activated at the time the solar pulse occurs, then the control phase angle is:

$$\beta = \beta_i - \frac{\pi}{2},$$

Assume that the time the rocket is activated is later than the solar pulse by τ_s, then the control phase angle β is:

$$\beta = \beta_i - \frac{\pi}{2} + \Omega\tau_s \tag{47}$$

i.e.,

$$\Omega\tau_s = \beta - \beta_i + \frac{\pi}{2}.$$

Considering equations (45), (46) and (47), obviously we have

$$\phi_1 = (t - t_{i_1})\Omega + \pi.$$

When $t = t_{i_1} + \tau_s$

then

$$\phi_1 = \tau_s\Omega + \pi = \beta - \beta_i + \frac{\pi}{2} + \pi.$$

Similarly, when $t = t_{i_2} + \tau_s$

$$\phi_1 = 2\pi + \beta - \beta_i + \frac{\pi}{2} + \pi.$$

$$t = t_{i_n} + \tau_s$$

$$\phi_1 = (n-1)2\pi + \beta - \beta_i + \frac{\pi}{2} + \pi. \tag{48}$$

Using equation (48), equation (36) becomes

$$M_k^* = \sum_{r=1}^{k} \begin{pmatrix} \cos(\beta - \pi) \\ \sin(\beta - \pi) \\ 0 \end{pmatrix} |M| \delta(t - t_{i_r} - \tau_s) = \begin{pmatrix} M_1^* \\ M_2^* \\ M_3^* \end{pmatrix}. \tag{49}$$

Because, in control maneuvers, the controlling moment of force is not large, and at the same time, the action ti[illegible] short, therefore it can be regarded that the impulse moment of each pulse is a first order infinitesimal quantity, i.e., we can assume the impulse of each pulse moment of force causing the angular momentum of the satellite to move an arc length of ΔS is

$$\int_0^t \frac{|M|}{h} \delta(\tau - t_{i_r} - \tau_s) d\tau = \Delta S. \tag{50}$$

Again neglecting higher order infinitesimal quantities, equations (26-31) can be simplified into the following linear equations:

$$\dot{\xi} = \frac{M_y^\Delta}{h\sin\eta}, \tag{51}$$

$$\dot{\eta} = \frac{M_x^\Delta}{h}, \tag{52}$$

$$\dot{h} = M_z^\Delta, \tag{53}$$

$$\dot{\phi}_1 = -\frac{h}{I_x}\mu\phi_2 + \frac{M_y^\Delta}{h}, \tag{54}$$

$$\dot{\phi}_2 = \frac{h}{I_x}\mu\phi_1 - \frac{M_x^\Delta}{h}, \tag{55}$$

$$\dot{\phi}_3 = \frac{h}{I_z}\left(\mu - \frac{I_z}{I_x}\right). \tag{56}$$

Let us assume that at t = 0, the initial conditions are:

$$\begin{cases} \xi = \xi_0 \\ \eta = \eta_0 \\ h = I_z\Omega = h_0, \end{cases} \tag{57}$$

$$\begin{cases} \phi_1 = 0 \\ \phi_2 = 0 \\ \phi_3 = 0. \end{cases} \tag{58}$$

Thus, the attitude movement before and after the first pulse moment of force acts is as follows: When $0 \leqslant t < t_{s1} + \tau_s$, we solve equations (51 - 53) and obtain:

$$\eta = \eta_0, \quad \xi = \xi_0, \quad h = h_0 = \Omega I_z. \tag{59}$$

When $t_{s_1} + \tau_s \leqslant t < t_{s_1} + \tau_1,$

If we consider the expression of the moment of force in equation (49), then from equations (51) and (52) we have

$$\eta_1 = \eta_0 + \Delta S\cos(\beta - \alpha) \tag{60}$$

$$\frac{d\eta}{d\xi} = \frac{M_x^\Delta}{M_y^\Delta}\sin\eta = \mathrm{ctg}\,\beta\cdot\sin\eta$$

By integration:

$$\xi_1 = \xi_0 + \mathrm{tg}\,\beta\ln\left\{\frac{\mathrm{tg}\frac{\eta_1}{2}}{\mathrm{tg}\frac{\eta_0}{2}}\right\} \tag{61}$$

It is not difficult to generalize the above results to the ξ and η after the kth pulse moment of force acts. If before the kth pulse acts,

$$\eta = \eta_{k-1}, \quad \xi = \xi_{k-1} \tag{62}$$

then after the kth pulse acts

$$\begin{cases} \eta_k = \eta_{k-1} + \Delta S \cos(\beta - \alpha) \\ \xi_k = \xi_{k-1} + \operatorname{tg}\beta \ln\left\{\dfrac{\operatorname{tg}\dfrac{\eta_k}{2}}{\operatorname{tg}\dfrac{\eta_{k-1}}{2}}\right\}, \end{cases} \quad (t_{s_k} + \tau_s \leqslant t < t_{s_{k+1}} + \tau_s) \tag{63}$$

In the following, we obtain ϕ_1, ϕ_2 from equations (54) and (55). Let

$$z = \phi_1 + \phi_2 i \tag{64}$$

then we change equations (54) and (55) into a complex number form:

$$\begin{cases} \dot{z} = \dfrac{h}{I_e}\mu z i + \dfrac{|M|}{h}\delta(t - t_{s_k} - \tau_s)e^{i(\beta - \frac{1}{2}\pi)} \\ z(t_{s_{k-1}} + \tau_s) = z_{(k-1)}, \quad (t_{s_{k-1}} + \tau_s \leqslant t < t_{s_k} + \tau_s) \end{cases} \tag{65}$$

It is not difficult to write equation (65) as

$$z(t) = z(k-1)e^{\Omega\mu i(t - t_{s_{k-1}} - \tau_s)}, \quad (t_{s_{k-1}} + \tau_s \leqslant t < t_{s_k} + \tau_s) \tag{66}$$

$$z(t) = z(k) = z_{(k-1)}e^{\Omega\mu T i} + \Delta S e^{i(\beta - \frac{1}{2}\pi)} \quad (t = t_{s_k} + \tau_s) \tag{67}$$

According to the known condition z(0) = 0

$$\begin{aligned} &z(1) = \Delta S e^{i(\beta - \frac{1}{2}\pi)}, \\ &z(2) = z(1)e^{\Omega\mu T i} + \Delta S e^{i(\beta - \frac{1}{2}\pi)}, \\ &z(3) = z(2)e^{\Omega\mu T i} + \Delta S e^{i(\beta - \frac{1}{2}\pi)}, \\ &\cdots \\ &z(n) = z(n-1)e^{\Omega\mu T i} + \Delta S e^{i(\beta - \frac{1}{2}\pi)}. \end{aligned}$$

Therefore

$$\begin{aligned} z(n+1) &= \Delta S e^{i(\beta - \frac{1}{2}\pi)}\{e^{\Omega\mu T i n} + e^{\Omega\mu T i(n-1)} + \cdots + 1\} \\ &= \Delta S e^{i(\beta - \frac{1}{2}\pi)}\left\{\frac{1 - e^{\Omega\mu T i(n+1)}}{1 - e^{\Omega\mu T i}}\right\}, \end{aligned} \tag{68}$$

where $T = \dfrac{2\pi}{\Omega}$.

In addition, we can also write equation (63) in a nonrecurrent form

$$\begin{cases} \eta_n = \eta_0 + n\Delta S\cos(\beta - \pi) & (69) \\ \xi_n = \xi_0 + \operatorname{tg}\beta\left\{\ln\left(\dfrac{\operatorname{tg}\frac{\eta_n}{2}}{\operatorname{tg}\frac{\eta_0}{2}}\right)\right\} & (70) \end{cases}$$

The conditions for equations (69) and (70) to be valid is $\eta_n = \eta_0$.
When $\eta_n = \eta_0$, according to equations (51 - 56) and equation (49), because at this time

$$\beta = \frac{\pi}{2}, \quad \beta = \frac{3}{2}\pi \qquad (71)$$

therefore

$$\xi_k = \xi_{k-1} + \frac{\sin(\beta - \pi)\cdot\Delta S}{\sin\eta_0}, \quad (t_{rk} + \tau_r \leq t < t_{rk+1} + \tau_r). \qquad (72)$$

The noncurrent form of equation (72) is

$$\xi_n = \xi_0 + n\cdot\Delta S\frac{\sin(\beta - \pi)}{\sin\eta_0}, \quad (t_{rk} + \tau_r \leq t < t_{rk+1} + \tau_r). \qquad (73)$$

From equations (67) and (68), the time after the nth pulse moment of force acts is

$$z(n) = \Delta S e^{i(\beta - \frac{1}{2}\pi)}\left\{\frac{1 - e^{\Omega\mu T i n}}{1 - e^{\Omega\mu T i}}\right\}, \quad (t = t_{rn} + \tau_r) \qquad (74)$$

Before the n + 1 pulse moment of force, and after the nth pulse moment of force,

$$z(t) = z(n)e^{\Omega\mu i(t - t_{rn} - \tau_r)}, \quad (t_{rn} + \tau_r \leq t < t_{rn+1} + \tau_r) \qquad (75)$$

because

$$\frac{1 - e^{2\pi\mu n i}}{1 - e^{2\pi\mu i}} = \frac{1 - e^{2\pi n(\mu-1)i}}{1 - e^{2\pi(\mu-1)i}} = \frac{\sin(\mu - 1)n\pi}{\sin(\mu - 1)\pi}\cdot e^{(\alpha_n - \alpha_1)i} \qquad (76)$$

$$\alpha_n = (\mu - 1)n\pi - \frac{\pi}{2} \qquad (77)$$

$$\alpha_1 = \pi(\mu - 1) - \frac{\pi}{2} \qquad (78)$$

Substituting equations (80 - 82) into equation (78) we obtain

$$z(n) = \Delta S\frac{\sin(\mu - 1)n\pi}{\sin(\mu - 1)\pi}\, e^{i(\beta - \frac{1}{2}\pi + (n-1)(\mu-1)\pi)} \qquad (79)$$

4. The Graphic Geometric Method and the Physical Significance of the Attitude Loci

It is not difficult to see from a comparison of the results of equations (69), (70), (71), (72) and (79) and the content of "the report" or reference (1) that the results obtained in this article are the direct generalization of the contents in "the report" or reference (1). The question discussed in "the report" and reference (1) is the special case when the control phase angle β of the desired attitude equals 0, π, and $\frac{\pi}{2}$, $\frac{3}{2}\pi$. As long as we let β equal to the above angle, the corresponding equations (75) and (76) which give the angular momentum coordinates are the coordinates of the angular momentum of the satellite described in "the report" or reference (1). At the same time, equation (83) gives the nutation radius

$$|z_{(n)}| = \frac{\sin(\mu-1)n\pi}{\sin(\mu-1)\pi}\Delta S. \qquad (80)$$

which is exactly the same as the nutation radius given in "the report" or reference (1).

To describe the attitude movement visibly, we can use the graphic geometric method to draw the loci of the vector and of the spin axis on the ϕ_1-ϕ_2 plane.

Example 1.

$$\beta = \frac{3}{2}\pi + \frac{\pi}{4}, \mu = 1.25, \xi_0 = 0, \eta_0 = \frac{\pi}{2},$$
$$\Delta S = 0.1,$$

Utilizing equations (69), (70), (71), (72), the angular momentum coordinates are:

$t = t_1$,	$\eta_1 = 1.5$	$\xi_1 = 0.07076$,	$t = t_5$,	$\eta_5 = 1.2172$	$\xi_5 = 0.3611$,
$t = t_2$	$\eta_2 = 1.4293$	$\xi_2 = 0.1418$.	$t = t_6$	$\eta_6 = 1.4650$	$\xi_6 = 0.4375$.
$t = t_3$	$\eta_3 = 1.3586$	$\xi_3 = 0.21374$.	$t = t_7$	$\eta_7 = 1.0758$	$\xi_7 = 0.5165$.
$t = t_4$	$\eta_4 = 1.2879$	$\xi_4 = 0.2869$.	$t = t_8$	$\eta_8 = 1.005$	$\xi_8 = 0.5985$.

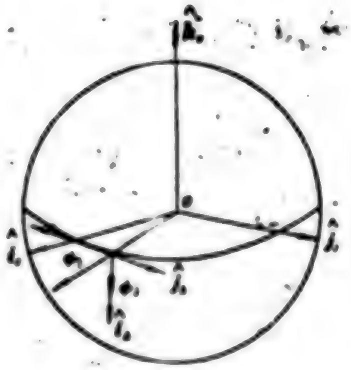

Figure 6. Relationship between the vectors of the ϕ_1 - ϕ_2 coordinates and the $\hat{i}_h$ $\hat{j}_h$ $\hat{k}_h$ coordinates system.

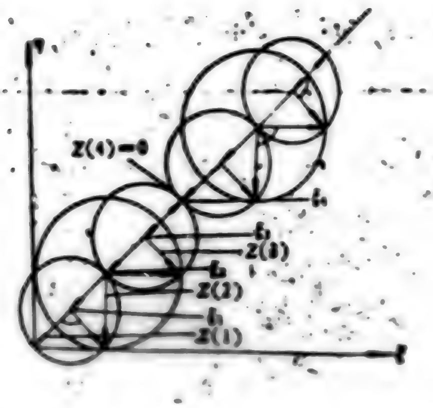

Figure 7. The phase diagram of the $\mu = 1.25$, $\beta = \frac{3}{2}\pi + \frac{\pi}{4}$ attitude movement in $\phi_1 - \phi_2$.

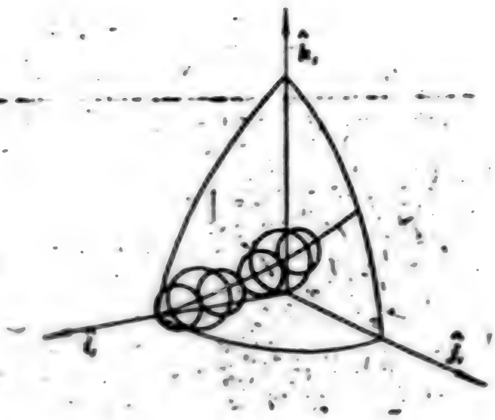

Figure 8. The loci of the vector end of the spin axis on the unit attitude spherical surface at $\mu = 1.25$ $\beta = \frac{3}{2}\pi + \frac{\pi}{4}$

Pattern of the phase angles:

$$
\begin{aligned}
z_{(1)} &= \Delta S e^{i\frac{\pi}{4}}, & z_{(5)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(4)} e^{i\frac{\pi}{2}}, \\
z_{(2)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(1)} e^{i\frac{\pi}{2}}, & z_{(6)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(5)} e^{i\frac{\pi}{2}}, \\
z_{(3)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(2)} e^{i\frac{\pi}{2}}, & z_{(7)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(6)} e^{i\frac{\pi}{2}}, \\
z_{(4)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(3)} e^{i\frac{\pi}{2}}, & z_{(8)} &= \Delta S e^{i\frac{\pi}{4}} + z_{(7)} e^{i\frac{\pi}{2}}.
\end{aligned}
$$

Figure 7 shows the phase diagram of the data in example 1 on $\phi_1 - \phi_2$.

To describe the attitude movement visibly, we can draw the loci of the vector end of the spin axis on the unit attitude spherical surface using the data in example 1. The loci are shown in Figure 8.

III. Comparison of the Results of Nonlinear Calculations

To examine whether the linear approximate analytic solution is applicable or not, we have obtained the numerical solution of the nonlinear equations of Eulerian dynamics on the digital computer and compared the results with the results obtained by the linear analytic equations. A set of results are copied here and listed in Table 1. Their detailed description is given in "the report".

Table 1

Symbol	Unit	Value Type \ ΩT Degree	30	90	120
R^*_{max}	Radian	Linear	0.306 × $10^{-[illegible]}$	0.913 × $10^{-[illegible]}$	1.21 × $10^{-[illegible]}$
		Nonlinear	0.306 × $10^{-[illegible]}$	0.913 × $10^{-[illegible]}$	1.21 × $10^{-[illegible]}$
θ^*	Degree	Linear	0	0	0
		Nonlinear	−1.1	−1.77	−2.58
k	Times	Linear	733	268	219
		Nonlinear	733	268	218
t_s	Second	Linear	244.3	89.3	73.0
		Nonlinear	244.3	89.3	72.6
θ	Kilogram	Linear	0.873	0.957	1.043
		Nonlinear	0.873	0.957	1.043

R^*_{max}	(radian):	Largest nutation radius of the control process;
θ^*	(degree):	Angle of θ^* as ψ^* advances 90° when the satellite is acted upon by the controlling moment of force;
k	(times):	The number of pulses needed to make the satellite's $\psi^* = 90°$.
t_s	(seconds):	Duration of time for the satellite's $\psi^* = 90°$.
Ω	(kilograms):	The amount of exhaust needed to make the satellite's $\psi^* = 90°$.

The comparison of the computed results shows that the linear analytic solution is a very good approximate solution and it is completely suitable for engineering design.

It can be clearly seen from Table 1 that the different fan shaped angles swept by the exhaust ($\Omega\tau$ = 30°, 90°, 120°) correspond to the different angles of exhaust when ψ^* varies from 0° → 90°. The values of R^*_{max}, k, t_e, θ are basically the same, the only difference is θ^*, in the linear approximate solution, $\theta^* = 0$ while the nonlinearity makes the values of the different angles of exhaust θ^* slightly different. Generally speaking, the larger the $\Omega\tau$, the larger the θ^*. Even so, the change in θ^* is not large, for designing attitude control, such precision is entirely sufficient.

In addition, this article also studied the effects of different values of μ, different external moments of force, different velocities of rotation upon the paremeters R^*_{max}, θ^*, k, t_e and θ under the different linear and nonlinear models, and their differences were compared. All of these results show the linear approximate analytic solution can be used in design, because the error caused by linearization is allowable within the range of precision of the problem discussed. For details, refer to the "report".

IV. Conclusion

(1) This article derived the approximate analytic solution of the attitude movement of mechanical maneuvers to position the spin satellite towards any desired target under "isogonic" control patterns.

(2) If the swept fan shaped angle of the exhaust is not larger than 30°, then when the desired attitude is reached, the error of control produced by the solution given by the linear model is only 1 percent to 2 percent of the advance of the desired attitude. Such errors of the model are allowable in the design of attitude control.

(3) In the analytic solution of the attitude, if we let $\beta = \frac{3}{2}\pi$ in equations (69), (70), (71), (72) and (79), we obtain the conclusion in "the report" or reference (1).

(4) The pattern of variation of the angular momentum in the course of control mainly relies upon the ratio μ of the vertical and horizontal inertia. Equation (79) actually describes the pattern of variation. According to this pattern, we can suitably select μ so that the periodically occurring nutation radius is zero, and on the other hand, after the inertia has been selected, we can also suitably select the number of times of control in attitude control so that after controlling maneuvers, the nutation radius is the smallest.

(5) The analytic solution of the attitude movement can directly be applied to the design of the spin satellite attitude control plan. According to this solution, we can conveniently determine the number of times of control. At the same time, this solution is also necessary in two-pulse control or nutation control.

(6) The analytic solution of the attitude movement can also be used to measure the attitude of the satellite, especially to measure nutation.

(7) We can utilize the analytic solution of the attitude to make a closed circuit attitude control system with an attitude feedback function. This means, we can utilize the attitude information sent by the satellite to determine the attitude in the control process, then we can feed back the estimated attitude to the attitude logic design and correct the attitude control logic in time.

The first draft of this article was reviewed by Mr Guang Zhaozhi [7070 5128 4160] and Comrade Bi Dachuan [3968 1129 1557] of the Systems Science Institute of the Chinese Academy of Sciences, and they expressed their precious opinions. Thanks.

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9296
CSO: 8111/1083

Building Construction

AUTHOR: None

ORG: None

TITLE: "Answers of Someone in Charge of a Related Department of the State's Bureau of Construction Engineering to Questions of a Reporter of the Journal Concerning Creative Superachievements"

SOURCE: Beijing JIANZHU [BUILDING CONSTRUCTION] in Chinese No 7, 30 Jul 81 pp 1-3

ABSTRACT: After the award meeting of the Beijing, Tianjin, and Tangshan Creative Superachievements Construction Competition, a reporter of the journal interviewed someone in charge of a related department of the State's Bureau of Construction Engineering asking about such problems as the method of further developing the competition activity. The official in charge provided some data to illustrate the accomplishments of the construction engineering system of the country (a State-operated enterprise. In 1980, 44,470,000m^2 of buildings were completed, and 5,916 buildings reached the creative superachievement level covering 12,910,000 m^2. Beijing was rated the best, with 86.6 percent reaching the award-winning level. It was above 40 percent for Tianjin, Shanghai, Liaoning, Jilin, and Yunnan; above 30 percent for Hebei and Shandong. Local superior engineering demonstrative projects were created in Shaanxi, Gansu, Xinjiang, Hubei, Zhejiang, Fujian, Shandong, and Guangdong. He credited scientific management, cost contracting, and various forms of work competition for these achievements.

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TITLE: "Department of Construction Made Great Contribution to Four Modernizations"

SOURCE: Beijing JIANZHU [BUILDING CONSTRUCTION] in Chinese No 7, 30 Jul 81 pp 6-7

ABSTRACT: On this day of the 60th anniversary of the birth of the Chinese Communist Party, it should be meaningful to review the accomplishments of the construction industry in the past 30 years. Following a brief history of various large plants all over the country being constructed very quickly, less than half of the time stipulated in the plan in some cases, the paper provides the following data: (1) From 1953 to 1980, the area of completed construction is 7.5×10^8 m^2, of which more than 50 percent are residential. (2) In 1980, the nation's construction team is composed of 3.2 million persons, 5.7 times the size of 1953. (3) There are 799 construction enterprises in 1980, 2.4 times the number in 1953. (4) The labor productivity in 1980 is 5,013 yuan/person, 83.3 percent higher than that of 1953.

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TITLE: "Comprehensive Utilization of Autoigniting Gangue"

SOURCE: Beijing JIANZHU [BUILDING CONSTRUCTION] in Chinese No 7, 30 Jul 81 p 15

ABSTRACT: There are many coal mines in Liaoning Province and every year a gigantic quantity of gangue is discarded. The amount discarded by Fouxin Coal Mine every year is about 2.3 million tons and there is a mountain-like accumulation, weighing 13×10^8 tons. A large area of land is taken by the gangue, which is a harmful pollutant. The Liaoning Provincial Bureau of Construction Engineering arranged for the Liaoning Provincial Research Institute of Construction Science to begin studying its comprehensive utilization in 1978, with the cooperation of other related organizations, emphasizing the feasibility of using gangue (1) as a light aggregate with ordinary cement as the adhesive material; (2) to make a powder (the autoigniting gangue of Fouxin) for mixing concrete to save some cement for the purpose of energy conservation; (3) to make autoigniting gangue reinforced concrete members to test its property under prolonged load bearing conditions. Following 3 years of research a production line has been established. The Fouxin Construction Member Plant is now using a large quantity of gangue to make floor boards and wall boards, which have been used to construct more than 30 residential dwellings, totaling 60,000 m^2. These boards have been scientifically certified as being light, strong, of good insulating property. The paper includ photos depicting gangue being extracted and a building constructed of gangue wall boards.

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TITLE: "An Underground Giant Dragon Cuts Across Yongjiang "

SOURCE: Beijing JIANZHU [BUILDING CONSTRUCTION] in Chinese No 7, 30 Jul 81 pp 27-28

ABSTRACT: It was in 1972, when the 100m pipe was being laid at Wusong Water Plant of Shanghai , the subject of laying large caliber long pipes began to be studied, along with such problems as reducing the friction resistance, controlling the sifting sand, etc. In 1979, the State included it as one of the key items of scientific research. Most recently, the pipeline across Yongjiang was completed. It measures 580 m in length and 2.6 m in diameter, with a directional error allowance of not exceeding ± 3cm. The pipeline is laid about 16 m from the surface. Due to the effect of tides, the gound water head is as high as 14-16 m. The difficulties encountered, the tools used, and new techniques adopted are very briefly mentioned. There are photos, presumably depicting the pipe but the caption says only: "Scientific technique is productivity."

6168
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TITLE: "ZL20 Loader"

SOURCE: Beijing GONGCHENG JIXIE [CONSTRUCTION MACHINERY] in Chinese No 6, 81 pp 1-5

ABSTRACT: The loader jointly made by Yichun Engineering Machinery Plant and Tianjin Research Institute of Engineering Machinery has just been certified by the State for production in batches. This paper introduces its applications, including shoveling loose materials, such as coal, sand, stones, etc., transporting it, or loading it on trucks, and below grade II soil excavation work. It is a multi-purpose construction machinery. Its major parameters and structure are described and illustrated with numerous drawings. A photo of the loader is on the front cover of this issue of the journal.

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TITLE: " BQZ Hydraulic Walking Type All Screw Drilling Machine"

SOURCE: Beijing GONGCHENG JIXIE [CONSTRUCTION MACHINERY] in Chinese No 6, 81 pp 5-8

ABSTRACT: The BQZ hydraulic walking type all screw drilling machine was made by Beijing Municipal Research Institute of Construction Engineering in 1977, on the foundation of the QZ_4 automobile style all screw drilling machine. It was a joint design of the institute, the Foundation Research Center, and other organizations, and was manufactured by Hebei Province Xinhe Drilling Machine Plant. In Oct 79, it was certified by the State and deemed to have the characteristics of being simply constructed, stable, capable of walking nimbly and aiming accurately, etc. It is now being produced in batches. The paper contains descriptions of its major technical parameters, its structure, and its application properties.

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TITLE: "Portal Jib of the Lift Type Crane"

SOURCE: Beijing GONGCHENG JIXIE [CONSTRUCTION MACHINERY] in Chinese No 6, 81 pp 8-10

ABSTRACT: The cranes dealt with in this paper include the caterpillar tread type and the wheel type guy derricks with a swinging arm. The portal jib is in the rear of the rotary platform, composed of a triangular frame on each side and a horizontal axle. A pulley is installed on the horizontal axle and a steel cable reel on the pulley to regulate the length and dip of the swinging arm. On the cranes extensively in use in China, the Q_{51} truck crane, the QL3-16 tire crane, the W501, the W1-06, the W1001, the Z801 (the Soviet Union,) the KU1206 (Poland,) the Z1252 (the Soviet Union) makes of caterpillar tread cranes, the height of the portal jib is all at 3.4-4.18m. For the convenience of transportation, the jib must not be higher than 4m. The jib of the 50 ton capacity caterpillar crane W2001 is 6.3m in height and must be taken down before the crane is moved. The structure, the function, the load capacity, and other parameters of portal jibs of various sizes are discussed.

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TITLE: "An Important Research Subject in Engineering Machinery, the Noise of Machines"

SOURCE: Beijing GONGCHENG JIXIE [CONSTRUCTION MACHINERY] in Chinese No 6, 81 pp 52-54

ABSTRACT: When engineering machinery is at work, the damages to the environment include noise, vibration, and exhaust pollution. This paper discusses only the problem of noise. The term noise includes sound and an irregular combination of it of various different frequencies. From the viewpoint of physiology, any sound that is annoying to humans is called a noise. Noise can reduce work efficiency and quality, increase the frequency of errors and accidents, and can even affect the health of the people, the normal operation of instruments and equipment, or damage building structures. This paper introduces medical and scientific data with respect to the harmfulness of noise, and conditions of foreign and domestic efforts in controlling noises caused by the operation of various machines.

6168
CSO: 4009/433

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TITLE: "Applications of Electronic Computers in Shanghai"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7, 20 Jul 81 pp 1-4

ABSTRACT: If the hardware system of computers may be said to be established on the basis of electronics, then the software system is on the basis of mathematics. From computations, applications of computers have been extended to management of economic activities, real time data processing, procedure control, etc. in a worldwide ratio of 3:7 or 2:8 favoring the latter forms, yet these applications are built on the foundation of mathematical description of events and solutions of mathematical problems. This paper discusses the relationship between mathematics and the new applications of computers in structural designing, stress analysis, designing of ships, railways, and highways, calculation of dynamic models, statistical analyses and simulation, processing graphics, production procedure control, artificial intelligence systems, etc. more in general terms than specifically in Shanghai, however. A few plants, such as Shanghai Yingxiong Pen Factory, Shanghai Wool Sweater Plant No 8, Shanghai Radio Plant No 20, Shanghai Steel Mill No 5, Shanghai Oil Refinery are briefly mentioned to be users of computers, without referring to details.

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TITLE: "Importance of Quality Control of Electronic Parts Considered in View of Spaceflight Technology"

SOURCE: Shanghai DIANZI JISHU [ELECTRONIC TECHNOLOGY] in Chinese No 7, 20 Jul 81 pp 22-24

ABSTRACT: Since the first artificial satellite was launched in 1957, by Aug 79, a total of 2378 space vehicles had been sent off by various countries of the world. The history of spaceflight technology has not been very long in China. Statistically speaking, the rate of success in 1976 was about 78 percent. Among the ventures that failed, malfunction of the key system is the cause of 55 percent of these, and 30 percent of the malfunctioned systems are the results of failures of electronic components. Artificial satellites require the electronic components to be highly reliable as well as to be adaptable to their special environments. The rate of losing effectiveness should be 10^{-7}/hour to 10^{-9}/hour; the radiation resistance 10^{4} to 10^{7} rad (silicon); the vaccum pressure 10^{-9} to 10^{-12} millimeter of mercury. Quality inspection, evaluation, and the limitations in quality control of electronic components are briefly discussed in terms of these high requirements.

6168
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TITLE: "Power Stoppage Over an Extensive Area"

SOURCE: Shanghai DIANSHIJIE [ELECTRICAL WORLD] in Chinese No 7, 81 p 22

ABSTRACT: On 27 Jul 80, with a big bang, the voltage mutual inductor (JCC 2-220) of a certain transformer substation in Anhui Province blew up. Flame, pieces of ceramics, and ramnants of other equipment were flying all over the place. The vibration ran through the entire power system of the province. In less than one hour, the power supply of 2 cities and 7 districts of central and southern Anhui stopped. The loss to industrial production was valued at more than two million. Subsequent analysis determined the cause to be mainly an inferior seal at the top of the voltage mutual inductor to cause it to become damp. Additionally, the internal insulation was poor so that the main insulation was blown through. Several such accidents had occurred in the East China Power Network. The seal is a very small item but it is the key to this piece of equipment. The paper suggests that a nitrogen or oil filled plastic sack should be placed on the top of the mutual inductor, with a piece of iron plate on top of the sack to form a small positive pressure inside the inductor to stop moisture or water from entering it. This method can also delay the deterioration of the lubricant.

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TITLE: "Close to One Hundred Persons Were Poisoned"

SOURCE: Shanghai DIANSHIJIE [ELECTRICAL WORLD] in Chinese No 7, 81 p 22

ABSTRACT: On 25 Jul 80, poisonous gas leaked out of a certain chemical plant in Shanghai and close to one hundred inhabitants were poisoned. The culprit of this catastrophe was the current mutual inductor (LCLWD3-220) of a certain transformer substation of Shanghai to cause 2 large capacity 220kw transformers to trip and the power supply of that chemical plant to stop. As a result, the chlorine pressure in the electrolysis tank rose and the chlorine gas spilled out to poison a large number of nearby residents. Investigation verified the fact that there were air bubbles inside the core insulation of the condenser in that mutual inductor. Many similar incidents had occurred before. The author suggests that condenser type current mutual inductors should be ultra-high vacuum treated to remove all air bubbles that may have been left by improper oil filling work.

6168
CSO: 4009/450

Engineering

AUTHOR: YUAN Ruilin [5913 3843 2651]
HE Laijing [6320 3200 1987]
HOU Xiangzhi [0186 4382 4249]
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XIAO Houjue [5135 0683 6030]
CHEN Jintian [7115 6930 3240]

ORG: YUAN, HE and HOU all of Taiyuan Institute of Technology; ZHANG, XIAO and CHEN all of Guangzhou Electronic Technical Institute, Chinese Academy of Sciences

TITLE: "Investigation and Manufacture of a V-type All-sliding Cubic Anvil Super High Pressure Apparatus"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 1-16

TEXT OF ENGLISH ABSTRACT: In this paper, the theoretical analysis and experimental research of a v-type all-sliding cubic anvil super high pressure apparatus are stated. The main factors of influence on compression accuracy are explained. The authors also suggest the calculating method of determining the optimal constructional parameters, and measure the increasing lifetime of the apparatus under continuously operation conditions so as to put it into industrial production from the experimental operation stage.

AUTHOR: ZHOU Rengen [0719 0088 2704]

ORG: Taiyuan Institute of Technology

TITLE: "An Elementary Exploration of Dynamic Programming Algorithm"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 17-26

TEXT OF ENGLISH ABSTRACT: In this paper four kinds of algorithms in which the state variables in the Bellman function of dynamic programming take the forms of discrete values are studied. By making use of these different approaches of the algorithms based on the different laws of the variation of decision function $d[s, X_n (s)]$ and maximum return function $f_{n-1}[X_n (s)]$, the amount of calculation work is reduced and the effect of the n-stage being optimal is ensured. In addition, a practical example for calculation is presented and the features of the above-mentioned algorithm are described.

AUTHOR: FAN Fengxi [5400 6646 2569]
SHANG Keqin [1424 0344 0530]

ORG: Both of Taiyuan Institute of Technology

TITLE: "The Analysis of List Sorting Algorithms"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 27-35

TEXT OF ENGLISH ABSTRACT: Of sorting methods both algorithms of list sorting are described in this paper, i.e., list insertion algorithm, list merge algorithm and their programs. According to the three principles of evaluating sorting algorithms, they are analyzed and compared. In the paper the methods of computation are abstracted and some tables are given to evaluate their sorting effect intuitively.

AUTHOR: LING Daqi [5677 1129 3823]
WANG Zhizhong [3769 1807 1813]

ORG: Both of Taiyuan Institute of Technology

TITLE: "Theoretical Calculation of Liquefaction Efficiency Based on Various Kinds of Coal in China"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 36-43

TEXT OF ENGLISH ABSTRACT: In this paper a thermodynamic method has been used to calculate the efficiency of coal liquefaction based on various kinds of coal. It is assumed that a hydrogen source (both enthalpy and hydrogen) is provided from the same kind of coal when it is converted into transportable fuel. The results from calculation for most kinds of coal indicate that in order to upgrade coal to fuel of $H/C = 1.6 \sim 2.2$, the actual fraction of coal used for liquefaction is about 60~75 percent. According to the International Classification of Hard Coal, coal classes 4, 5, 6 and 7 have higher liquefaction efficiency, but the lignite containing much more oxygen gives a poor percentage efficiency.

AUTHOR: GAO Mingyuan [7559 2494 6678]

ORG: Taiyuan Institute of Technology

TITLE: "The Calculating Method of Indoor Non-sanitary Fixtures for One or More Closed Circuit Water Supply Pipe Systems"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 44-56

TEXT OF ENGLISH ABSTRACT: This article is to offer the hydraulic calculation method of indoor non-sanitary fixtures for one horizontal and one or more vertical closed circuit water supply pipe systems through examples. The common characteristic features of this method deal with the working conditions of the designed maximum discharge of the closed circuit and with determining the pipe diameters and water head.

AUTHOR: CUI Yuchuan [1508 3768 1557]

ORG: Taiyuan Institute of Technology

TITLE: "The Analysis of the Relation between the Siphonic Filter's Depth and Its Design Rate of Filtration"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 57-66

TEXT OF ENGLISH ABSTRACT: This paper discusses the design depth (the maximum water head of filtration), the checking purpose, content and method of the siphonic filters through the analysis of the relation between the siphonic filter's depth and its rate of filtration, and an explanation of a few kinds of rates of filtration and a discussion of the selection of the design rate of filtration are also included. In addition, it demonstrates the inner links of the current experimental data or parameters, such as the filter's design rate, the washing head, the maximum filtrating head, etc.

AUTHOR: TU Shuji [3205 2885 1015]

ORG: Taiyuan Institute of Technology

TITLE: "A Mechanical Method of Adjusting Trilateral Nets with Central Figures"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 67-81

TEXT OF ENGLISH ABSTRACT: In this paper the mechanical method has been introduced for the adjustment of trilateral nets with central figures. This method is based on the principle of minimum work in mechanics, and the result of adjustment has exactly the same value as is obtained by calculations from the least squares method. It offers a direct and simple solution and shows the advantage of using this method for adjusting trilateral nets.

A complete numerical example has been provided in this paper from which the adjusted value of sides, coordinates and positional accuracy of points can be directly obtained.

AUTHOR: ZHANG Hengxin [1728 1854 2450]

ORG: Taiyuan Institute of Technology

TITLE: "The Distribution of the Curvature Center of Circular-arc-gears"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 82-89

TEXT OF ENGLISH ABSTRACT: As the distribution of the curvature center of circular-arc-gears has a bearing on wearability, movement property, engagement parameters and other factors, in this article various distribution schemes according to the tooth wear, gear vibration noise, strength, etc., are analyzed and compared. Reasonable distribution schemes with gears on the parallel axis drives are thus obtained.

AUTHOR: LI Yuanzong [2621 0037 1350]

ORG: Taiyuan Institute of Technology

TITLE: "Analysis and Calculation of Motion States of Industrial Robots"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 90-111

TEXT OF ENGLISH ABSTRACT: An analysis and calculation method of motion states of industrial robots is described in this paper by transformation of coordinate systems. The author presents in detail a relationship between the elements in the transformation matrix and the parametric variables of motion, builds a set of fundamental equations of motion variables, and derives a group of simple formulas for the inverse matrix of the transformation matrix. A parallel shaft mechanism which may be resolved is also introduced and the motion parameters for two types of industrial robot devices are calculated with practical examples. This method is a practical tool both for developing the industrial robot mechanism and for realizing the automation of complex machines.

AUTHOR: WANG Shengkun [3769 0524 0981]

ORG: Taiyuan Institute of Technology

TITLE: "An Approach to Some Important Properties of Analytic Signals"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 112-117

TEXT OF ENGLISH ABSTRACT: In this paper some important properties of analytic signals are approached. The conclusion we have arrived at is not at all similar to the traditional one that has been used for years. In this paper we suggest that the convolution of one analytic signal and the complex conjugation of another one, as well as their correlative integration, should not be equal to zero unconditionally. In general cases they should be constants which are not equal to zero, but are equal to the product of zero-frequency values of two analytic signals.

AUTHOR: XU Wenyang [1776 2429 2543]
GUO Changjie [6753 1603 2212]

ORG: Taiyuan Institute of Technology

TITLE: "The Theory of Volume Filling for Microporous Adsorbents"

SOURCE: Taiyuan TAIYUAN GONGXUEYUAN XUEBAO [JOURNAL OF TAIYUAN INSTITUTE OF TECHNOLOGY] in Chinese No 2, 1981 pp 118-126

TEXT OF ENGLISH ABSTRACT: The development of the theory of volume filling for micropores adsorption of gases and vapors is summarized in this paper.

9717
CSO: 4009/366

AUTHOR: MEI Houjun
et al.

ORG: None

TITLE: "Ophiolite Series in Qinghai-Tibet Plateau and Genesis of the Ophiolite in Western Tibet"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 107-113

TEXT OF ENGLISH ABSTRACT: Several ophiolite belts and an ophiolite assemblage have been discovered in the Ali region and the Upper Valley of the Yarlung Zangbo River. As is shown by alkalisilicon and titanium-zirconium diagrams of volcanic rocks from these ophiolite belts, most of the volcanic rocks in these regions may not have been produced from the ocean floor. Cretaceous volcanism in western Tibet bears a strong resemblance to that of the present day Pacific Arc. Based on a review of ophiolite distribution on a worldwide scale, the authors suggest classifying the four major orogenic regions into four "ophiolite series," i.e., the Qinghai-Tibet, the Altay, the Alpine and the Circum-Pacific ophiolite series. Among other things, all the blocks, large and small, in the crust seem to be forced to converge respectively at the four places as a result of continental drift during the last billion years.

AUTHOR: RAN Chongying [0373 1504 5391]

ORG: Kunming Engineering Institute

TITLE: "On the Sedimentary Environment and Diagenetic-Metallogenesis of Dongchuan Type Stratiform Copper Deposit in the Kangdian Earth's Axis"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 114-119

TEXT OF ENGLISH ABSTRACT: In the present paper it is suggested that the bay or lagoon areas of the post-reef of stromatolith and the bathyal areas of pre-reef were water basins where copper ores were deposited, the former corresponding to syngenetic dolomite facies of post-reef bay or lagoon environment and the latter to black shale-dolomite facies of pre-reef building. It is concluded that the stratiform copper deposits are genetically of diagenesis and closely related to stromatolith reef, but not directly to the tuff in sedimentary origin.

AUTHOR: ZHANG Rubo [1728 1172 2672]
GONG Xiasheng [7895 1115 3932]
ZHOU Zhendong [0719 2182 0392]
et al.

ORG: All of Chengdu Geological Institute

TITLE: "Muchuanite, A New Water-bearing Molybdenum Sulfide Mineral"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 120-127

TEXT OF ENGLISH ABSTRACT: Muchuanite, a new water-bearing molybdenum sulfide mineral, was discovered in a series of molybdenum-bearing feldspathic quartz-sandstone of the Jurassic system, Sichuan Province, China.

Muchuanite is dark, powdery and very finely scaled with specific gravity of 5.01 (meas) and 5.10 (calc), and microhardness of 16-35 kg/mm^2. Optically, it is uniaxial (-). Refractive index in air R_g = 26.6 - 29.5 percent, R_p = 12.3 - 14.2 percent, color index X = 0.3114, Y = 0.3748, λ_d = 566 mμ, and Pe = 14.4 percent.

The chemical composition of muchuanite is given as follows: Mo 52.88, 54.20; S 37.34, 36.00; Fe n.d., 2.2; Si n.d., 0.5; H_2O^+ 6.03, 5.95; H_2O^- 2.07, 1.00; total 98.59, 99.85. Chemical and electron microprobe analyses gave the following formula: MoS_2 0.5 H_2O.

[Continuation of DIQIU HUAXUE No 2, 1981 pp 120-127]

Muchuanite is trigonal with space group C_{3v}^1 = P3ml, unit-cell parameters a = 3.16 Å, c = 43.60 Å, v = 377.09 Å, z = 7, and a unit-cell contains 3.5 water molecules.

The strongest lines given by X-ray diffraction pattern (d, Å, intensity hkl) are 6.013 (10, 0. 0.7); 2.677 (8, 0. 0.16); 2.257 (7, 0. 0.19); 1.567 (7, 1. 1.3); 1.523 (7, 0. 0.28); 1.096 (3, 1. 1.28); 1.021 (3, 0. 0.42).

Muchuanite is syngenetic with feldspathic quartz sandstone. The mineral is named after the locality where it was discovered, i.e., Muchuan County in Sichuan Province.

AUTHOR: CHEN Yuwei
et al.

ORG: None

TITLE: "A Discussion of Zircon U-Pb Dating of Intermediate Acid Rocks in Southern Xizang"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 128-135

TEXT OF ENGLISH ABSTRACT: U-Pb isotopic geological ages were determined on more than 30 specimens of zircon, feldspar, sphene and apatite from the Kangdese rock belt and its eastern Bome-Zayu areas in Xizang (Tibet). The study of common lead derivation and its mode of occurrence in zircon indicates that large amounts of common lead occur as sulfide-facies minerals or exist in the crystal lattice of zircon, rather than being introduced by contamination during analytical procedure. Described in this paper is the validity of subtracting zircon-containing common lead from the isotopic components of syngenetic galena, consequently leading to the conclusion that intermediate-acid rocks in the studied region are brought forth by Late Yenshanian (120-80 m.y.) movement. It is suggested from the quantity of common lead and the difference in lead isotopic composition that the western segment of the Kangdese belt and its eastern Bome-Zayu areas may have two different material sources.

AUTHOR: ZHANG Yuquan
et al.

ORG: None

TITLE: "On the Crustal Movement Characteristic of the Xizang Plateau with Special Reference to Intermediate-Acid Magmatic Activities"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 136-141

TEXT OF ENGLISH ABSTRACT: In view of their distinct NWW trending and their decreasing geological age from north to south, intermediate-acid magmatic rocks in the southern part of Xizang can be divided into three petrographical belts in general: (1) the Kangdese belt (120-10 m.y.). The major part of the belt is mainly composed of diorite, granodiorite, etc., more intermediate in chemical composition and ranging from 120-70 m.y. in age; (2) the Lhangoi Kangri belt (30 m.y.); and (3) the Himalaya belt (20-10 m.y.). From their intruding features, spacial-temporal consistency, intruding scale, petrological characteristics and chemical composition, it is suggested that these three petrographical belts seem to be closely related to plate underthrust and collision.

It may be concluded that the major part of the Kangdese belt resulted from the underthrust of the Indian Ocean Plate toward the Eurasian Continental Plate, while the Lhagoi Kangri belt and Himalaya belt are the results of collision of the Indian sub-continental plate overlying the Indian Plate with the Eurasian Continental Plate.

AUTHOR: LIU Dongsheng
et al.

ORG: None

TITLE: "The Model of Environmental Quality for Yunnan Province and Keshan Disease"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 142-150

TEXT OF ENGLISH ABSTRACT: Discussed in this paper are the regularities governing the prevalence of Keshan disease and its relationship to the local rock type, soil, vegetation, climate and landform, as well as to the characteristic variations of stereo-environment--environmental gradient in Yunnan Province. Based on the foregoing discussion, the gradations of environmental quality and the coefficients of environmental quality mirroring the general picture of physical environment there have been determined, and a model of environmental quality has been established with an attempt to detail the relationship between the factors of environmental geology and Keshan disease.

AUTHOR: WEN Qizhong
et al.

ORG: None

TITLE: "A Preliminary Investigation of REE in Loess"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 151-157

TEXT OF ENGLISH ABSTRACT: REE oxides in loess are estimated to amount to about 200 ppm. The REE distribution patterns in loess and its clay fraction are characterized by the enrichment of rare earth elements of the Ce family.

The REE distribution patterns of loess in the middle Huanghe (Yellow River) Valley are consistent with those of sands from the Tengeli desert, probably indicating the consistency of their material sources. The REE distribution patterns are similar to each other in the clay fractions of Malan loess everywhere in the middle Huanghe Valley, indicating the homogeneity in their composition. Close to the average value of the earth's crust, the REE distribution patterns in loess and its clay fraction are similar to those of sedimentary rocks (e.g., North American shales), but different from those of chondrites. This seems to show that large amounts of loessic material were transported from the provenance by moving water into sedimentary systems after having been separated from its precursor, and then transported by wind to where it is now distributed.

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WU Weifang [0702 5898 5364]
LI Shi [2621 1102]
ZONG Puhe [1350 2528 0735]

ORG: XU, WU and LI all of the Institute of High Energy Physics, Chinese Academy of Sciences; ZONG of the Institute of Geochemistry, Chinese Academy of Sciences

TITLE: "Mossbauer Study of Apollo-17 Mare Basalt"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 158-161

TEXT OF ENGLISH ABSTRACT: The results of a Mössbauer study of Apollo-17 Mare basalt are reported in this paper. It has been revealed that Fe in iron-bearing minerals in the basalt is usually present in the form of Fe^{2+}, with Fe^{3+} less than 3 percent of total iron. The site occupancy of Fe^{2+} ions at M_1 and M_2 is approximately 0.3 and the corresponding equilibrium constant K (T) is about 0.06, thus indicating that the mare basalt is formed through crystallization under high-temperature reducing and rather slow cooling conditions.

AUTHOR: ZHANG Jinlai [1728 6855 0171]

ORG: Petroleum Geological Brigade No 101, Ministry of Geology

TITLE: "Some Hydrogeochemical Processes Related to the Formation of Terrestrial Oil Field Water in China"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 162-173

TEXT OF ENGLISH ABSTRACT: Terrestrial oil field water from the Upper Permian to Tertiary in China is characterized by great variation in its chemical composition. According to the first three predominant ions, oil field water can be classified into four categories, i.e., HCO_3-Cl-Na, Cl-HCO_3-Na, Cl-Na-Ca and Cl-SO_4-Na, which are referred to as categories A, B, C and D for simplicity.

From comparison of the features of oil field water with those of terrestrial evaporation water, in conjunction with available experimental results, five different hydrogeochemical mechanisms are suggested for oil field water evolution. They are: the evaporation and concentration, the biochemical process, enrichment of trace elements, diffusion of petroleum components and various exchange processes, including the exchange of cations, dolomitization, isotope exchange and the reverse exchange of anions. Chemical characteristics and some regularities concerning oil field water are interpreted in terms of these mechanisms.

AUTHOR: FENG Weiheng

ORG: None

TITLE: "Determination of Intrusive Relation between Two Rock Masses by Using Statistical Analysis of Regression Coefficients"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 174-180

TEXT OF ENGLISH ABSTRACT: Statistical analysis of regression coefficients is used to determine whether or not the two granites under investigation resulted from the same stage of magmatism. This method is especially powerful when the relationship remains ambiguous based on geological data. Encouraging results are also obtained by applying this method to the division of the mineralization stage as well as to the examination and revision of isotopic age data of igneous bodies.

AUTHOR: LIN Xuenong

ORG: None

TITLE: "Tectonic Compression Characteristic of the Ultrabasic Rocks in Dazuka Profile"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 181-184

TEXT OF ENGLISH ABSTRACT: The ultrabasic rocks of Dazuka form the eastern part of the Rinbung-Bainang ultramafic massif which is mainly composed of harzburgite intercalated with dunite, and high in MgO. This ultrabasic massif is assigned to magnesian ultramafic massif of Alpine type. In these ultrabasic rocks the major minerals are forsterite, enstatite, diopsite and chrome spinel. The rocks are very fresh and, therefore, texture and structure characteristics of compression during tectonic movement are commonly observed.

Undulatory extinction, polysynthetic twin, kink band structure, elongation and contortion of olivine and orthopyroxene crystals, radiating cracks occurring around the chrome spinels, etc., are commonly observed phenomena.

All these features show that the massif was under constant action of tectonic compression during its evolution process, and after it was basically consolidated. It is reasonable to consider that the tectonic compression was related to plate collision between the Indian and Eurasian plates.

AUTHOR: ZHANG Guangyu
et al.

ORG: None

TITLE: "Analysis Results of International Geochemical Reference Samples"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 185-188

TEXT OF ENGLISH ABSTRACT: The analytical procedures used for many years in our institute for rock analysis are tested against 18 international geochemical reference samples provided by CRPG, ANRT and USGS. The validity of our method and its suitability for widely different samples are substantiated by the good agreement between our results and the recommended values.

AUTHOR: WANG Shengyuan
et al.

ORG: None

TITLE: "Temperature Gradient in Cold-seal Pressure Vessels"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 189-196

TEXT OF ENGLISH ABSTRACT: Temperature gradient curves are given for 0.5 - 2 kbar and 300-600°C based on internal temperature measurements, and an empirical formula

$$t_x = T + (a_0 + a_1T + a_2T^2 + a_3T^3 + a_4T^4 + a_5TP + a_6P)x$$

is established to calculate the temperature at any point, x, within the bomb. Uncertainty of 90 percent of estimates by using this formula is less than 5 degrees. In most instances, real pressure within the bomb is only 60 to 80 percent of the designed pressure as based on P-V-T relations due to the existence of temperature gradient. This large pressure departure can be reduced to less than 30 bars by using

$$\bar{t} = 11.6 + 0.8973T + (0.01 - 2.06 \cdot 10^{-5}T - 5.664 \cdot 10^{-8}T^2 + 8.8667 \cdot 10^{-11}T^3)(P - 1250)$$

on the assumption of uniform temperature within the vessel.

[Continuation of DIQIU HUAXUE No 2, 1981 pp 189-196]

All temperature-dependent properties, such as water fugacity, ionization constant, and the solubility of gas in fluid phase, will vary with this temperature gradient. On the other hand, because the pressure within the bomb stays uniform, there must be an opposite gradient with respect to water density. Therefore, variations will likewise be expected in all the properties which are a function of water density, such as the dielectric constant and activity coefficient. These variations may be important for the interpretation and understanding of some experimental results.

AUTHOR: ZHONG Honghai [6945 4767 3189]
HU Guohui [5170 0948 6540]
XU Hanqing [6079 3352 0615]
et al.

ORG: All of the Guangdong Institute of Analysis

TITLE: "Determination of Uranium in Minerals by Delayed Fission Neutron Method"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 197-202

TEXT OF ENGLISH ABSTRACT: A brief account is given of the principle of the delayed fission neutron method and the related equipment for the determination of uranium in minerals by this method. The whole experimental procedure was autoprogramatically controlled. The neutron flux was monitored and delayed fission neutrons were measured in a multiscale mode by a multichannel analyzer. The method has the advantages of relative simplicity, quick performance, high accuracy, non-destruction and low cost. Its standard deviation is $\pm$ 0.2 percent and sensitivity 388 n/μg U. The comparison shows that the results obtained by this method are in good agreement with those obtained by other methods. Finally, the problem of interference in measurement is also discussed.

AUTHOR: ZHAO Minguang [6392 2404 0342]

ORG: Research Group of Quantum Chemistry, Sichuan Teachers College

TITLE: "Point Group Symmetry Magnetic Interactions and Application to Ruby"

SOURCE: Beijing DIQIU HUAXUE [GEOCHIMICA] in Chinese No 2, 1981 pp 203-207

TEXT OF ENGLISH ABSTRACT: By utilizing the magnetic interactions possessing C_{3v} symmetry, the author deduced the general expressions for the g-factors, zero-field splitting and effective magnetic moment of the ground singlet orbital state in the d^3-complex. For the ruby (Al_2O_3:Cr^{3+}), the results are in good agreement with experiments: theoretical values: $g_{//} = 1.9835$, $g_{\perp} = 1.9876$; $2D = -0.373\ cm^{-1}$; $\mu_{//} = 3.857\beta$, $\mu_{\perp} = 3.861\beta$; experimental values: $g_{//} = 1.9840 \pm 0.0006$, $g_{\perp} = 1.9867 + 0.0006$; $2D = -0.3831 \pm 0.0002\ cm^{-1}$; $\mu = 3.8 - 3.9\beta$.

9717
CSO: 4009/398

AUTHOR: WANG Dachun [3769 1129 4783]
ZHANG Renquan [1728 0086 5425]

ORG: None

TITLE: "Evaluation of Confined Ground Water Resources in Porous Media and Their Relationship With Surface Subsidence"

SOURCE: Beijing SHUIWEN DIZHI GONGCHENG DIZHI [HYDROGEOLOGY AND ENGINEERING GEOLOGY] in Chinese No 3, 81 pp 1-3, 8

ABSTRACT: Since the middle 50's, for evaluation of ground water resources, China had been using the 4 classifications, introduced from the USSR, of natural dynamic reserve, regulating reserve, permanent reserve, and mining reserve. Problems began to appear as early as the 60's, mainly concerning the fact that the technique is very unsuitable for evaluating crevice, load bearing water. Just about the same time, the problem of surface subsidence began to be gradually discovered in China. These 2 problems are not identical, yet according to present studies, any occurrence of surface subsidence is related to the extraction of fluids, water, petroleum, natural gas, etc. In consideration of the background, this paper begins with reclassifying ground water into the 2 types of renewable and nonrenewable. The composition of crevice, load bearing aquifer system or confined ground water resources is analyzed. When mining of nonrenewable aquifer has caused the water table to recede and funnels to form, permanent ground surface subsidence will occur following a reduction of the water pressure. Some surface subsidence data of Shanghai of China and California of the USA are included in the discussion.

AUTHOR: LIN Mujin [2651 2606 6855]
YE Heliang [0673 0735 5328]
LI Weicai [2621 4850 2088]

ORG: All of The 517 Team, North China Metallurgy and Prospecting Company

TITLE: "Understandings From Hydrogeological Prospecting of the Xishimen Iron Deposit"

SOURCE: Beijing SHUIWEN DIZHI GONGCHENG DIZHI [HYDROGEOLOGY AND ENGINEERING GEOLOGY] in Chinese No 3, 81 pp 9-13, 57

ABSTRACT: Xishimen iron deposit belongs to a typical crevice karst type mineral region with a complex hydrogeological condition. The deposit is located in the west side of Wuan basin, with the terrain higher in the west and lower in the north in a region of low mountains and hills of limestone and igneous rocks. A seasonal stream, Mahe, flows across the middle and the river bed has piles of sandy gravel, several to ten plus meters in height. The mean annual precipitation is 560 mm, concentrated mostly in Jul and Aug. The difficulty in the hydrogeological prospecting work is mainly in estimating the quantity of surge of water. In the beginning (1959) 4 small holes were drilled to pump water from each to obtain the infiltration coefficient of 0.495, 1.00, 2.96, 4.10 m/day. On this basis, the surge was estimated and later it was discovered to be more than 10 times higher than the estimate. In 1966, in connection with regional geological and hydrogeological investigation, 45 large holes were drilled, in addition to many extensive observations. The complicated process of learning is described.

AUTHOR: ZHENG Keyan [6774 0344 8568]

ORG: None

TITLE: "Comprehensive Utilization of Geothermal Resources of Beijing"

SOURCE: Beijing SHUIWEN DIZHI GONGCHENG DIZHI [HYDROGEOLOGY AND ENGINEERING GEOLOGY] in Chinese No 3, 81 inside from cover

ABSTRACT: The underground hot water in the Beijing region belongs basically to medium-low warm type temperature water, but practice of its utilization of many years has proved that it is extensively useful. In the process of mining, attention should be given to the problem of evaluation and recharge experiment must also be carried out beforehand. The fluorine content of the geothermal water is rather high and corrosion prevention studies should also be emphasized. Contents of radium, iron, and radon, etc. of the water of some places far exceed the standard for drinking water; therefore, timely consideration of the pollution effects of prolonged discharge of this hot water is also extremely import and attention should be given to its prevention and control. The paper also includes 6 photos depicting (1) Using geothermal water to wash and dye cloth (Guanghua Dyeing and Weaving Plant); (2) Geothermal Bath (People's Machine Plant); (3) Hot water therapy (Xiaotangshan Sanitarium); (4) Hot water for industrialized fish culture (Changping Marine Products Breeding Farm); (5) Geothermal greenhouse (Yaowa Production Team); (6) Geothermal earthquake observation (Jingmian [Beijing Cotton] Mill No 3.)

6248
CSO: 4009/446

AUTHOR: GU Zengdi [7357 2582 6611]

ORG: None

TITLE: "Tungsten Electrode Manual Argon Arc Welding of Titanium and Titanium Alloys"

SOURCE: Shanghai JIXIE ZHIZAO [MACHINERY] in Chinese No 7, 81 pp 14-16

ABSTRACT: Titanium and titanium alloys have good corrosion resistant property, low specific gravity, and high strength. They also have some heat resistance and machining capability. Due to these physical, chemical, and heat treatment properties, they are being more and more extensively used in airplanes, rockets, missiles, space vehicles, chemical engineering machines, oil refinery equipment, sea water desalinization equipment, medical instruments, meters, etc. and for the same reasons special welding technique is required for joints of this material. Melt electrode automatic argon arc welding is used for plates larger than 10mm; vacuum argon welding for articles of complicated shapes. For plates smaller than 10mm the most extensively adopted technique is the tungsten electrode manual argon arc welding technique. Specifications of materials for which this technique is suitable are given in a table. Preparations before welding and the welding procedure are described.

AUTHOR: None

ORG: None

TITLE: "Collected Papers of 1980 Annual Conference of Shanghai Municipal Mechanical Engineering Society to be Published"

SOURCE: Shanghai JIXIE ZHIZAO [MACHINERY] in Chinese No 7, 81 p 46

ABSTRACT: In 1980, several scientific discussion meetings concerning the improvement of product quality and conserving energy resources were held by the Shanghai Municipal Mechanical Engineering Society. Papers, 46 of them, submitted to these meetings, have been selected for publication; 14 of these papers are judged to be superior and are to be published unabridged. The remaining 32 papers are to be published in abstracts. In order to calculate the number of copies needed, organizations and individuals are here requested to write to the Shanghai Municipal Mechanical Engineering Society (47 Nanchang Road, Shanghai) to declare the number of copies they want. The society will reply by mail when the date of publication is certain. There will be a charge to cover the cost of publication.

6248
CSO: 4009/447

AUTHOR: CHEN Tiequn [7115 6993 5028]

ORG: Wuhan College of Engineering

TITLE: "Effects of Soft Nitridation on the Abrasion Resistance of Steel"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 6, 81 pp 1-6

ABSTRACT: This paper discusses and evaluates various soft nitriding treatments of steel and their effects on resistance to abrasion by hard fretting, scuffing, or rubbing and on corrosion resistance. Under given conditions, nitriding treatments are compared with results of other methods of treatment. With regard to occasions with different abrasive mechanism as the leading action, the test results reported in this paper may serve as the experimental data of practical significance for the selection of a relatively more reasonable technique of surface treatment for steel.

AUTHOR: CHEN Longgao [7115 7127 7559]

ORG: Beijing Automobile Manufacturing Plant

TITLE: "Solid Solution-Time Effect Hardening of HPb59-1 Brass"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 6, 81 pp 29-31

ABSTRACT: Several automobile parts of the Beijing Automobile Manufacturing Plant are made of HPb59-1 lead brass and are formed through hot forging. When the parts are assembled, cracks and disengaged threads are regularly discovered and these parts must be discarded. For the purpose of finding the reasons of this problem, some experiments are carried out. Through metallic phase and hardness inspections, the α-phase (white colored) is discovered to be distributed, in the form of large net-like stripes or lumps, on the β-phase (black colored,) being a typical overheating situation, but the hardness is very low, only HRB40-45. The hardness of the undamaged parts is all above HRB70. It is the conclusion of the studies that during the forging process, the temperature is excessively high while the pieces are also slowly cooling off to cuase the crystalline grains to be rough and large and to deteriorate. The solid solution-time effect hardening technique is recommended as a remedy, with 750-760°C heating, water cooling, and one hour time-effect at 350°C.

AUTHOR: DENG Dongchang [6772 2639 2545]

ORG: None

TITLE: "Heat Treatment to Strengthen QA19-4 Aluminum Iron Bronze"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 6, 81 pp 35-42

ABSTRACT: Unlike aluminum alloys, beryllium bronze, and other colored metals, the QA19-4 aluminum iron bronze depends mainly upon quenching to obtain the β' phase of the martensite type to improve its strength, This paper introduces the heat treatment procedure and its relationship to the β' phase in the hope of finding a relatively ideal heat treatment process for this alloy. Some suggestions are included concerning the aluminum content of QA19-4 aluminum iron bronze corresponding to the YB 458-71 standard.

6168
CSO: 4009/434

AUTHOR: ZHANG Ziyuan [4545 1311 0337]

ORG: Beijing College of Aviation

TITLE: "Hydrochloric Acid Catalytic Nitriding Technique"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 7, 81 pp 1-8

ABSTRACT: This paper reports an experiment with the direct use of hydrochloric gas as the catalytic nitriding agent. The mechanism of the nitriding action of the gaseous hydrogen chloride is analyzed. Through routine gaseous nitridation, techniques of electrolytic gaseous catalytic infiltration nitridation, hydrochloric acid catalytic infiltration nitridation, and air-added hydrochloric acid catalytic infiltration nitridation are compared. Results demonstrate that the nitriding depth, hardness, and brittleness of these techniques are similar to results of routine nitridation in terms of carbon steel, alloy steel, and stainless steel, with the white layer slightly thicker and the hardness slightly higher. The speed of infiltration of the hydrochloric acid catalytic nitriding method is faster than the routine method, while the nitriding result is the same as the electrolytic gaseous method and the danger of explosion of the sealed electrolytic tank may be avoided.

AUTHOR: ZHANG Furui [1728 4395 3843]

ORG: Dalian Motor Vehicle Plant

TITLE: "Experimental Research on Medium Carbon Steel Laser and Electron Beam Surface Quenching Technique"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 7, 81 pp 20-25

ABSTRACT: Laser and electron beam surface quenching are techniques of very fast heating and self-cooling method of quenching the metal surface with high energy density particle beam. Many countries are studying it and a few countries are applying it in production. In consideration of some quality problems with 45 steel and 42CrMo steel, the author and colleagues experimented with these advanced techniques. Results indicate that the surface quenching effects on 42CrMo steel vary as the size of the electron beam is adjusted; as the power of the electron beam increases, the hardness, the width of the quenching zone, and the depth of the quenching layer also increase. With the laser surface quenching technique, it appears to be necessary to proceed with "melanizing treatment" of the surface of the metal parts first. The electron beam method should be applied in a vacuum chamber. They are both more complicated than other surface treatment techniques, but neither require a spray cooling medium.

6168
CSO: 4009/448

AUTHOR: None

ORG: The Collaborating Group for the Prevention and Treatment of Dengue Fever, Foshan, Guangdong

TITLE: "Etiologic and Serologic Investigation During an Epidemic of Dengue Fever in Foshan District of Guangdong Province in 1978"

SOURCE: Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese No 2, 1981 pp 239-246

TEXT OF ENGLISH ABSTRACT: During the summer and autumn of 1978, an epidemic of dengue fever occurred in Foshan District. From blood specimens taken during the acute stage of certain patients with clinical manifestations, three strains of dengue virus type IV were isolated. Through a study of 180 acute-convalescent paired sera and a survey of 109 single blood samples of convalescent patients, it has been found that the causative agent was also evaluated to be the same type of dengue virus. By an investigation of the antibody level of the normal population of this area, both during pre-epidemic and epidemic periods, it was found that the antibody titer of 1:32 or lower in a single specimen of suspected dengue fever may be of diagnostic value. It has also been observed that the complement fixation titer began to rise within a week after the beginning of the disease, and the peak titer was reached by the third week, eventually dropping to 1:64 or lower at the

[Continuation of WEISHENGWU XUEBAO No 2, 1981 pp 239-246]

third month. For the complement fixation test, the antigen prepared from brain suspension of infected mice should first be treated with freezing and thawing three times, and finally extracted by a sucrose-acetone mixture to reduce the nonspecific reaction of the crude antigen.

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CAO Yousong [2580 0645 2646]
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et al.

ORG: All of the Changchun Serum and Vaccine Institute, Changchun

TITLE: "Studies of Attenuated Tick-borne Encephalitis Vaccine. I. Selection of Attenuated Strain"

SOURCE: Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese No 2, 1981 pp 247-256

TEXT OF ENGLISH ABSTRACT: In order to increase peripheral multiplication and enhance immunogenicity, the suckling mouse variant "Sof" was subpassaged continuously in mice, guinea pigs and gold hamsters. After passage, attenuated variants selected showed very low degrees of neurotropism. By an intracerebral route of inoculation, it was incapable of causing disease or death in either the hamster or M. rhesus, and its pathological changes in the brain were nearly negligible. This variant retained its intracerebral pathogenicity in the mouse and was antigenically similar to the original line. It was thus concluded that this strain of virulence is more attenuated for the mouse as are other reported strains.

The immunogenicity of variant "HS6" strain was tested in 171 volunteers without prior TBE virus experience or history of allergic state, by the subcutaneous

[Continuation of WEISHENGWU XUEBAO No 2, 1981 pp 247-256]

route of one dose. No local or generalized reaction was observed. The sera were assayed for specific virus neutralizing antibodies against the TBE virus strains "Chang" and "Sof," and the sero-conversion rate appeared to be 38-60 percent.

9717
CSO: 4009/384

Oceanology

AUTHOR: ZHU Jimao [2612 4949 2021]

ORG: Shanghai Jiaotong University

TITLE: "Analysis of Special Considerations in the Design of Submersibles"

SOURCE: Beijing HAIYANG XUEBAO [ACTA OCEANOLOGICA SINICA] in Chinese Vol 3 No 2, Jun 81 pp 307-329

TEXT OF ENGLISH ABSTRACT: As the submersible is widely different from ordinary submarines in both its purpose and its working conditions, special requirements must be met in hull construction, operation control, equipment and communication and navigation systems. Because its energy source is limited, the cruising range of the submersible is very small and it has to be carried by other vehicles. Consequently, strict displacement requirements must also be met. Therefore, the principle of design and method of analysis of the submersible are greatly different from those of ordinary submarines. Based on experience in the design of the submersible and some related research work, the author analyzed special considerations in the design of the submersible, starting with the weight equation and the equation of motion, and obtained the following conclusions:

1. In order to reduce the displacement of the shallow water submersible, a big pressure hull should be designed so as to use as little buoyancy material as possible, since the relative proportion (γ_c) of the pressure hull of the submersible in shallow water is smaller than the relative proportion (γ_b) of the buoyancy material. As for the submersible in deep water with γ_c greater than γ_b,

[Continuation of HAIYANG XUEBAO Vol 3 No 2, Jun 81 pp 307-329]

a small pressure hull should be designed instead and equipment should be placed outside it.

2. Reduction of the relative proportion of the pressure hull has a great influence on the reduction of the displacement of the submersible. Within certain limits of relative depth, γ_c can be reduced when the material strength is raised and a ball-shaped pressure hull is used. But when the hull is to be used within limits of stable depth, raising the material strength has little influence on the reduction of γ_c and the ball-shaped pressure hull is not necessarily better than a cylindrical one. From the perspective of raising the actual safety factor, keeping close manufacturing tolerance is more effective than reducing the quantity of tolerance factors.

3. The specific gravity of seawater and the capacity of the submersible change with the temperature and salinity of the water and the diving depth of the submersible. According to data of the China coast, changes in these aspects can lead to a great change in buoyancy. The change in buoyancy can be resolved into dw_R (change in buoyancy due to the difference in sea areas) and dw_z (change in buoyancy due to the difference in depth of seawater). The former can be adjusted by submersible solid ballast and the latter by a buoyancy adjustment system in the submersible. The characteristics of the variation of buoyancy with the depth of seawater are determined by the relative magnitude of the changes in specific gravity and in capacity. When the specific gravity change is greater than the capacity change, the submersible is statically stable with respect to depth. When

[Continuation of HAIYANG XUEBAO Vol 3 No 2, Jun 81 pp 307-329]

the specific gravity change is smaller than the capacity change, the submersible is not statically stable with respect to depth. Different adjustment schemes must be used in each case respectively.

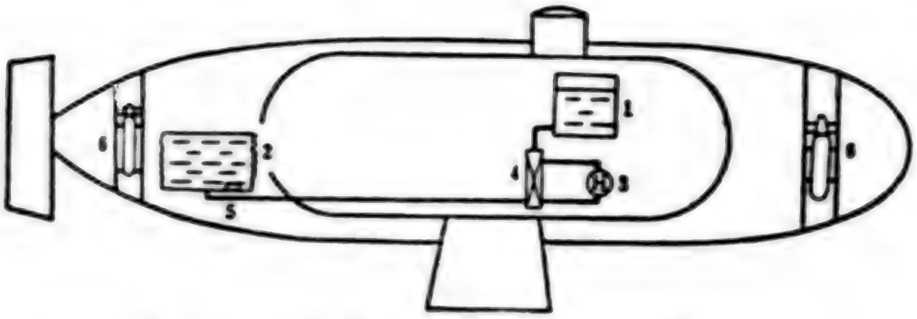

Figure 9. Diagram of Buoyancy Regulation System

Key:

1. Oil tank	4. Electromagnetic valve
2. Bag	5. Spacing switch
3. Hydraulic pressure gauge	6. Propeller

[Continuation of HAIYANG XUEBAO Vol 3 No 2, Jun 81 pp 307-329]

4. Calculation of the characteristics of the practical scheme of buoyancy adjustment and model test show that the linear buoyancy adjustment system is stable only when the rate of flow controlled by the velocity signal and acceleration signal is very high. The nonlinear adjustment system is stable when the rate of flow controlled by the velocity signal is much greater than that controlled by the depth signal. In order to avoid using highly sensitive velocity and acceleration transducers and proportion valves, the nonlinear depth adjustment scheme of additional vertical thrust can be adopted. Model tests show that good matching can give fairly good results.

9717
CSO: 4009/396

AUTHOR: WU Kaisan [0702 7030 3790]

ORG: None

TITLE: "Cavern Anchor Blown Support Constructuction Technology"

SOURCE: Chongqing DIXIA GONGCHENG [UNDERGROUND ENGINEERING] in Chinese No 6, 81 pp 9-13

ABSTRACT: In the process of constructing anchor support for the top of a natural cave at a certain engineering project and the cavern of another engineering project, the technique of long distance blowing was adopted. The results were very satisfactory. A WG-25 jet sprayer and a HPX negative pressure jet sprayer were used, in addition to a forced concrete mixing machine. The material was blown to a maximum distance of 255m at a maximum drop of 35 m. Details of the anchoring and support structures, the spraying tools, the dust preventing measures, and various procedures of preparation are described. This technique appears to have basically resolved the problem of dust in this type of construction process, but continued study on better spraying machines and liquid solidifying agents are still needed.

AUTHOR: None

ORG: None

TITLE: "The First Electronic Computer Work of Railway Tunnels Experience Exchange Meeting"

SOURCE: Chongqing DIXIA GONGCHENG [UNDERGROUND ENGINEERING] in Chinese No 6, 81 p 23, inside front cover

ABSTRACT: The first electronic computer work of the railway tunnel specialty experience exchange meeting, sponsored by the Bureau of Tunnel Engineering of the Ministry of Railway and the Second Survey and Designing Academy was held 21-28 Apr 81 in Chengdu. Participants included 52 delegates of 17 organizations including the Bureau of Basic Construction, the Scientific Research Academy, the Southwest Scientific Research Institute, and the various designing academies of the Ministry of Railways, Jilin Bureau of Railway, Southwest Transportation University, North China Transportation University, Changsha Railway College , Shanghai Railway College, Shanghai Tunnel Research Institute, Chongqing Branch of the Ministry of Transportation Scientific Research Academy, Tongji University, et al. In recent years, electronic computer technology has been extensively popularized in the various units of the railway system. In some instances, it is combined with model experimentation and site surveying data to make the design closer to reality. In computation theory, the finite-element method is extensively applied, and from

[continuation of DIXIA GONGCHENG No 6, 81 pp 23, inside front cover]

linear analysis, the technique has expanded to nonlinear analysis, from the elastic theory, it has expanded to elastic plasticity theory. With the new developments in the extension and application of electronic computer technology, the need to develop computerized optimization designing, automatic graphics etc. is also discussed. Aspects of computer technology concerning program verification and management also form a part of the experience exchange.

6248
CSO: 4009/435

AUTHOR: HU Yuxian [5170 5124 6343]

ORG: None

TITLE: "Progress in the Technique of Underground Bomb Shelter Structure Designing Analysis in View of the 1974 USA Air Force Manual"

SOURCE: Chongqing DIXIE GONGCHENG [UNDERGROUND ENGINEERING] in Chinese No 7, 81 pp 4-10

ABSTRACT: In consideration of the advancement in nuclear weaponry and increased understanding of its effect on civil engineering structures since the publication of the USA Air Force Manual of Dec 1962, a research project was organized under the leadership of the Defense Atomic Support Agency of that country and the 1974 Air Force Manual was compiled by the Civil Nuclear Systems Corporation, with the Air Force Weapons Laboratory, the Air Force Systems Command, and the Kirtland Air Force Base participating. After comparing the contents of the 2 manuals very briefly, this paper proceeds to introduce the progress in underground blast resistant structural designing, based upon the new manual, in the 3 aspects of (1) Free field pressure attenuation; (2) Determination of structural load; (3) Analysis of structural designing. Although the new manual is much improved, considerations of many problems remain to be the one dimensional effect of wave propagation. Many two dimensional and three dimensional effect phenomena are not reflected. In the opinion of the author, a great deal of investigation and study are still needed to produce an even more complete and simple to follow manual for bomb protection structural design.

AUTHOR: TIAN Yujia [3944 5940 3946]

ORG: None

TITLE: "Comprehensive Discussion of the Condition of Model Experiment of Underground Structures, in China and Abroad"

SOURCE: Chongqing DIXIE GONGCHENG [UNDERGROUND ENGINEERING] in Chinese No 7, 81 pp 11-18

ABSTRACT: The major purpose of experiments with underground structural model made of a brittle material is to determine the distribution of stress of surrounding rocks and the phenomenon of destruction to provide data for designing support and reinforcement. Following a discussion of the major goals and contents of these model experiments and principles for selecting materials to make the model, the specifications of force or load applying platforms used for model experiments in China, the USA, Japan, W. Germany, Italy, and Mozambique are briefly introduced.

6248
CSO: 4009/451

Vacuum Technology

AUTHOR: CHEN Jianzhong [7115 1696 0022]
SUN Qida [1327 0120 6671]

ORG: None

TITLE: "A New Ultra-high Vacuum Thermal Gage--An Axial Hot Cathode Ionization Gage"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 3, 81 pp 1-6

ABSTRACT: This paper proposes a new axial thermal gage, with a structure different from that of the existing BA type gages. The characteristics of the new gage include high sensitivity, small scattering, simple structure, easy degassing, and wide range of measurement. Electron and ion movement tracks of the gage are analyzed and some experiments are carried out to determine the effects of the electrode structure and parameters on sensitivity.

AUTHOR: CHEN Peijin [7115 0012 3866]
WANG Humin [3769 4375 3046]

ORG: Both of Qinghua University

TITLE: "Reverse Diffusion Equation of Steady Viscous Flow Gas and Its Application"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 3, 81 pp 31-43

ABSTRACT: This paper proposes 2 solutions to the one dimensional reverse diffusion equation of steady viscous flow gas. The general form of the three dimensional (cylindrical coordinates) steady gaseous viscous flow reverse diffusion equation is also discussed. Attempts are made for 2 conditions of two dimensional space under a specific situation to produce the density distribution of reverse diffusion flow, but this work is obviously in need of further efforts. Finally, various applications of the reverse diffusion equation and its solution in vacuum technology, especially in diffusion pump system to obtain a clean vacuum are introduced.

AUTHOR: QIU Chuxiang [5941 2806 3276]

ORG: Hangzhou Electron Tube Plant

TITLE: "Reform of the Work Process of Stainless Steel Soldering "

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 3, 81 pp 50-51

ABSTRACT: When stainless steel is soldered in vacuum, with the vacuum lower than 10^{-5} torr, or if it is soldered in a hydrogen furnace, with the hydrogen dew-point higher than -60°C, oxidation will occur to cause the soldered place to leak gas. In order to prevent stainless steel from oxidation in the course of rising temperature, it is necessary to apply nickel plating at the soldered place, but nickel plating is a complicated procedure, and the phenomenon of bubbling occurs easily. Based upon the fact that titanium has the action of making the crystal of steel finer and the fact that titanium is also a strong deoxidising agent, the author and colleagues adopted a new technique of not using nickel plating. On the soldering surface, a layer of titanium ointment is painted. The soldering work is successful in a $4 \times 10^{-4} - 10^{-5}$ torr vacuum. The soldered piece is air-tight after prolonged use under -260°C. With this new method, stainless steel may be soldered to stainless steel and stainless steel to oxygen-free copper and a relatively high tensile strength may be obtained.

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CSO: 4009/430

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